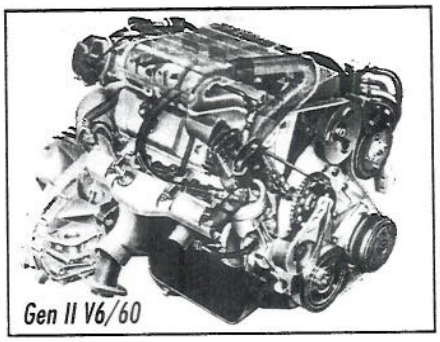
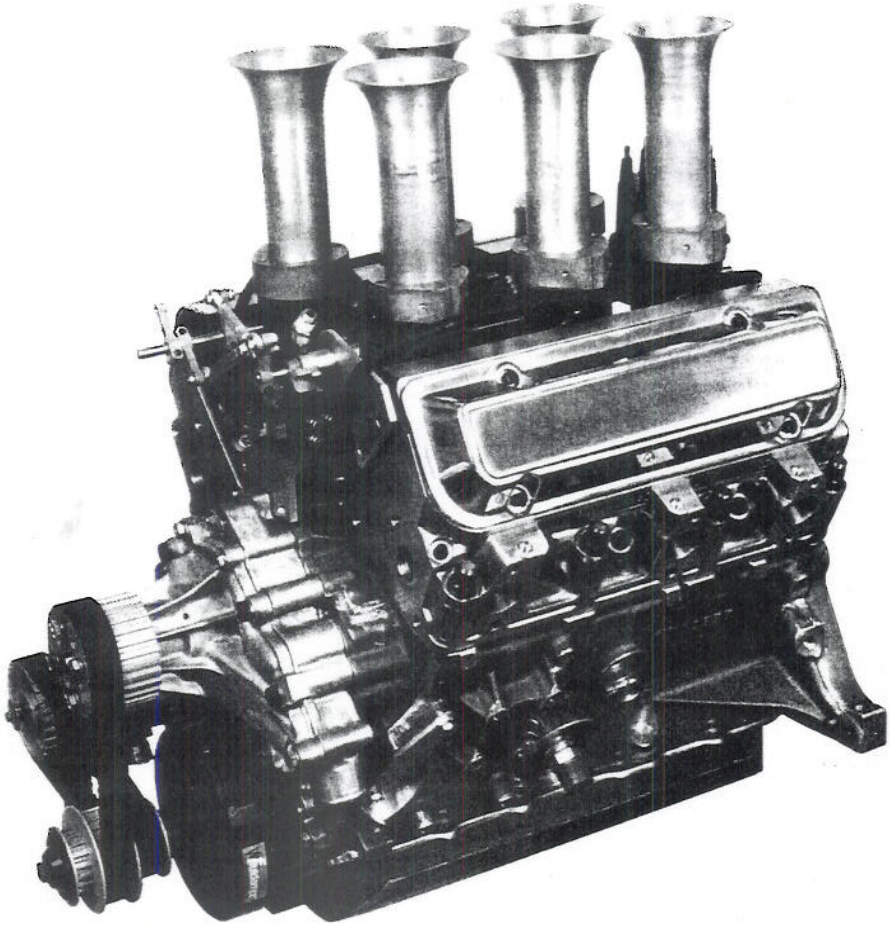
Chevrolet 60-Degree V6


Gen II V6/60



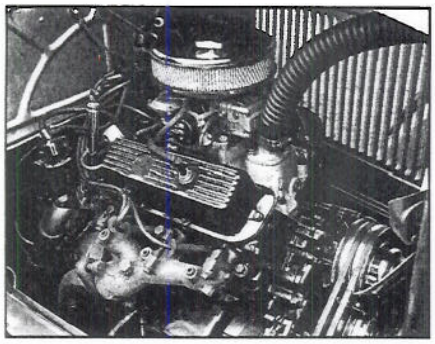
- Chevy's Versatile V6
- Compact and Powerful
- A Lightweight Contender
- DOHC and Splayed-Valve Variations

The Chevrolet 60-degree V6 has earned a solid reputation for performance and reliability in competition. The V6/60 Chevrolet has won championships in off-road racing, set records in drag racing, and won honors in midget oval track competition. The light weight and ample traction of a front-wheel-drive V6/60 powertrain has made this compact Chevy engine a favorite in autocrossing and other forms of motorsports that emphasize precise handling and quick response. The 60-degree V6 has also found favor with innovative street rodders seeking a lightweight, fuel-efficient powerplant.

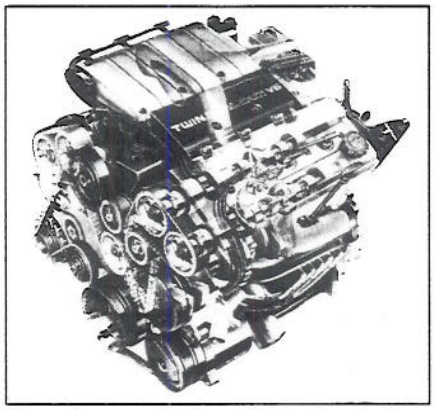
The 60-degree V6 is a unique member of the family of Chevrolet engines. It is the only Chevrolet engine used in both transverse and longitudinal installations, and it is the only motor in the Chevy lineup with a 60-degree included angle between its cylinder banks. (Small-block V8s, big-block V8s, and 4.3-liter V6 engines all have 90-degree vee angles).

The specifications and procedures in this chapter are intended primarily to aid enthusiasts in preparing the Chevrolet V6/60 engine for "off-highway" and emission-exempt operation. Due to the diversity of sanctioning bodies' rules and the special demands of various types of motorsports, an engine may require specific preparation procedures and accessories not covered in this manual. These specifications and recommendations are intended as guidelines that have been tested and proven by leading competitors.

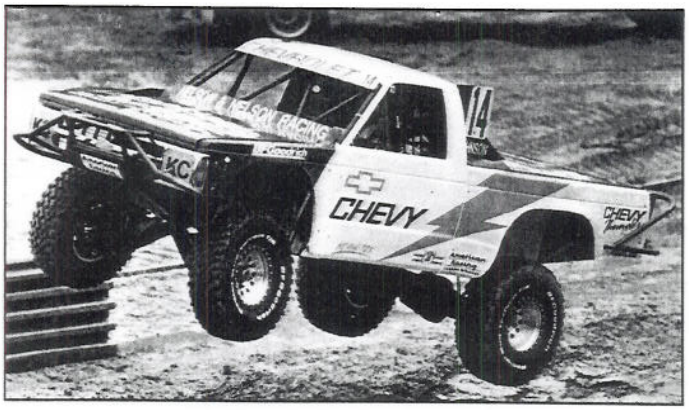
This chapter describes parts and procedures that are unique to V6/60 engines. For information on engine building and



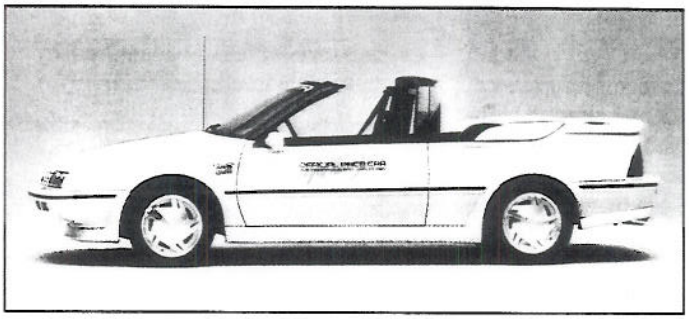
Savvy street rodders have discovered that the Chevrolet V6/60 is a contemporary alternative to traditional V8 powerplants.



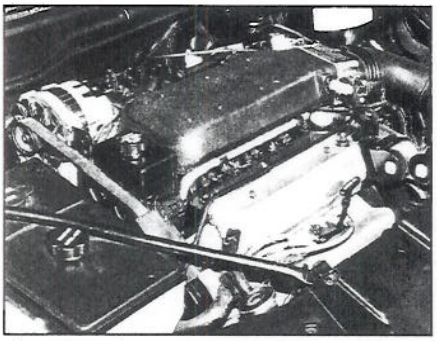
The sophisticated 3.4-liter/210hp Twin Dual Cam V6/60 debuted in 1991 with dual overhead cams and four valves per cylinder.



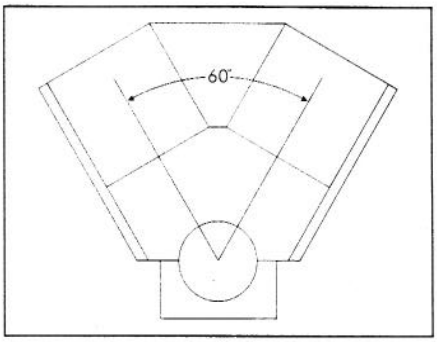
Nelson & Nelson Racing's Chevy pickup flies high in the MTEG stadium racing series with a 3.0-liter 60-degree Chevy V6.



Chevrolet General Manager Jim Perkins paced the 1990 Indianapolis 500 with a V6/60-powered Beretta.



The 1990 Indy 500 Beretta pace car's 3.4-liter V6 produced 225 horsepower with Generation II aluminum heads and electronic fuel injection.



The included angle between the V6/60's two cylinder banks is 60 degrees—hence the engine is referred to as a "60-degree V6."

blueprinting procedures, ignition systems, and lubrication requirements, see the respective chapters on these topics.

V6/60 Engine Design

The Chevrolet 60-degree V6 ("V6/60") was introduced in 1980 as a 2.8-liter (173ci) transverse-mounted engine in the front-wheel-drive Citation chassis. A rear-wheel-drive version of the V6/60 debuted in 1982 in the S-10 pickup, S-10 Blazer, and Camaro. This dual application accounts for several minor differences between V6/60 engines, including starter location, motor mounts, and manifold water inlet locations. All specifications in this chapter apply to both configurations, however.

The term "60-degree V6" refers specifically to the included angle between the engine's cylinder banks. In the V6/60 Chevrolet, this angle is 60 degrees. (Chevrolet's "other" V6 has a 90-degree Vee angle.) The "60-degree" designation does *not* refer to the number of degrees between cylinder firings. The Chevrolet V6/60 is a true "even-fire" engine, with a uniform 120 degrees of crankshaft rotation between each cylinder firing.

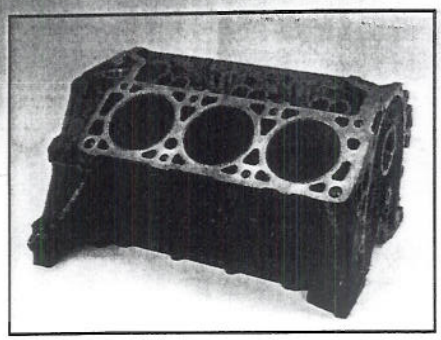
The V6/60 was Chevrolet's first all-metric engine. The bolts and fasteners used in V6/60 engines have metric threads exclusively. The dimensions shown on the V6/60 blueprint are expressed in metric units. To convert millimeter dimensions to inches, divide by 25.4 or multiply by .03937.

2.8-liter V6/60 Chevrolets have 89mm (3.50-inch) cylinder bores and 76mm (2.99-inch) strokes. A 3.1-liter V6/60 was introduced in 1990 with an 84mm (3.31-inch) stroke, and a 3.4-liter version debuted in 1991 with 92mm (3.62-inch) cylinder bores. All V6/60 engines have the same cylinder bore spacing (111.8mm/4.40-inch) and the same block height (224mm/8.819-inch).

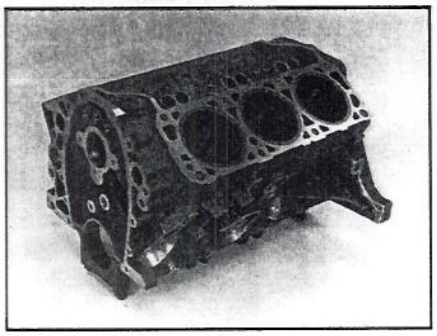
The V6/60 has been continuously updated and improved since its introduction. In 1985, the crankshaft journal diameter was increased 4mm to improve

TECH SPECS: V6/60 DESIGN FEATURES

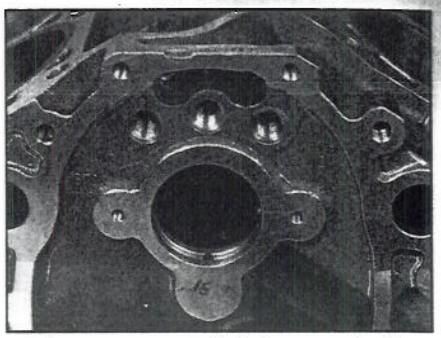
Engine Displacement	Model Year	Bore	Stroke
2.8-liter (173ci)	1980-89	3.50" (89 mm)	2.99" (76 mm)
3.1-liter (191ci)	1990-94	3.50" (89 mm)	3.31" (84 mm)
3.4-liter (207ci)	1991-94*	3.62" (92 mm)	3.31" (84 mm)
	*DOHC introduced 1991; OHV introduced 1993		



A production cast iron engine block is a good choice for off-road competition. A rear-wheel-drive V6/60 bare block weighs 106 pounds.



Chevy's lightweight V6/60 aluminum Bow Tie block has 89mm cast nodular iron cylinder liners and four-bolt intermediate bearing caps.



An aluminum Bow Tie block has V8-style oiling with three oil galleries. The center gallery feeds the cam and main bearings.

durability, and multi-port fuel injection was developed to enhance performance. New aluminum cylinder heads with high-flow ports and splayed valves signaled the arrival of the "Generation II" V6/60 in front-wheel-drive applications at the start of the 1987 model year. A dual overhead cam version with four valves per cylinder followed in 1991.

Engine Blocks

All production V6/60 engine blocks are cast iron. Unlike other Chevrolet engines, the V6/60's *right-hand* cylinders (when viewed from the rear of the block) are forward of the left-hand cylinders. The right-hand cylinders (passenger's side in fore-and-aft installations) are numbered 1, 3, 5 from front to rear. The left-hand cylinders are numbered 2, 4, 6 from front to rear. The firing order is 1-2-3-4-5-6.

A production cast iron block (with main caps and bolts) for a front wheel drive chassis weighs approximately 101 pounds. A rear-wheel-drive block is five pounds heavier. The nominal cylinder wall thickness for production V6/60 blocks is 4.5mm (.175-inch).

An important difference between early-model (1980-84) and late-model (1985 and newer) V6/60 blocks is the diameter of the main bearings. 1980-84 engines have 63.35mm (2.494-inch) mains, while 1985 and later engines use 67.25mm (2.648-inch) main bearings. (Note: The diameter of the No. 3 main bearing was changed to 63.13mm in 1982; in 1985, it was enlarged to 67.25mm.) All 1985 and later 2.8-liter V6/60 engines with multi-port fuel injection have large diameter main bearings; S-10 pickups, Blazers, and carbureted engines manufactured in 1985 can have either large or small main bearings. A block with large diameter crankshaft journals can be easily identified by its one-piece rear crankshaft seal.

Production V6/60 blocks are suitable for high-performance street use, off-roading, and limited competition applications. Production V6/60 blocks used in SCORE/HDRA off-road racing routinely produce over 270 horsepower and provide hundreds of miles of trouble-free operation at high engine speeds. A late-model block with large main bearings is recommended for all high-performance applications.

Aluminum Bow Tie Block PN 10051141

An aluminum Bow Tie V6/60 cylinder block (PN 10051141) is recommended for all maximum-effort competition engines. This block offers improved durability, lighter weight, and more displacement options than production cylinder cases. Aluminum V6/60 blocks are suitable for competition engines with displacements ranging from 2.5 to 3.0-liters, depending on the bore and stroke dimensions selected by the engine builder.

A bare aluminum Bow Tie block (with main caps) weighs 59 pounds—a weight savings of 47 pounds over a rear-wheel-drive production block. The aluminum Bow Tie engine block has extra-thick cylinder walls with dry cylinder liners. These cast nodular iron cylinder sleeves are rough-bored at the factory to 89mm (3.504-inch) diameter; they can be safely enlarged to 91mm (3.582-inch). A 3.0-liter V6/60 racing engine can be assembled by installing a production 76mm (2.99-inch) stroke crankshaft in a Bow Tie block that has been bored to 91mm.

The Bow Tie block has reinforced head bolt bosses that improve head gasket sealing. The main bearing bulkheads are thicker than production blocks to increase bottom end strength. Cast iron front and rear caps and billet steel intermediate caps are installed at the factory. The four-bolt intermediate main bearing caps (Nos. 2 and 3) have angled outer studs. High-strength 11mm studs are supplied with the Bow Tie block.

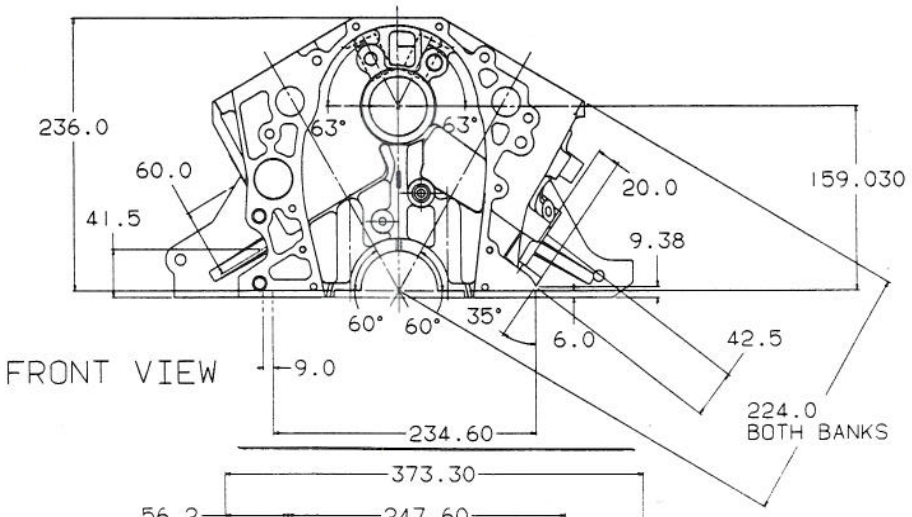
The heavy-duty aluminum Bow Tie V6/60 block has an oiling system that is similar to a production small-block V8's lubrication system. Three oil galleries are drilled above the camshaft; annular grooves in the camshaft bearing bores carry oil from the center oil gallery to the main bearing saddles. (Production V6/60 blocks have only two oil galleries above the camshaft. The large left-hand lifter oil gallery feeds the lifters, the camshaft bearings, and the main bearings.)

The Bow Tie block's revised lubrication system routes most of the oil directly to the crankshaft bearings to improve reliability at high engine speeds. This design also allows an engine builder to restrict the flow of oil to the lifter galleries.

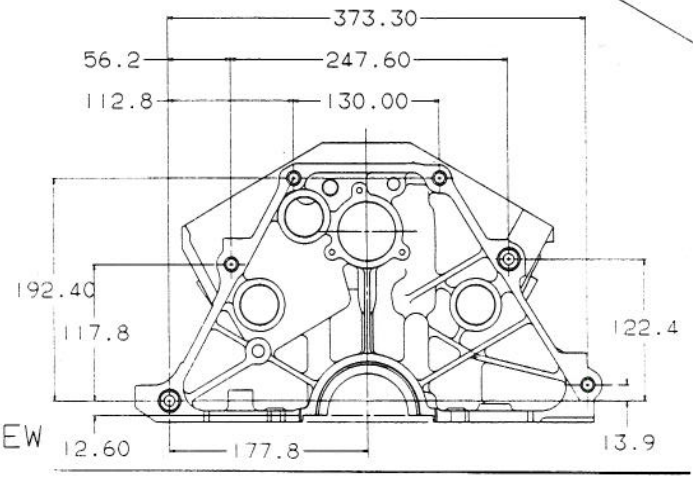
The aluminum Bow Tie block has motor mount bosses for both front-wheel-drive and rear-wheel-drive applications. The starter motor can be mounted on either side of the block to accommodate a variety of chassis configurations. Aluminum blocks also have provisions for production ignition timing sensors, coil packs, and mechanical fuel pumps. The oil filter bypass spring is deleted.

Block Preparation

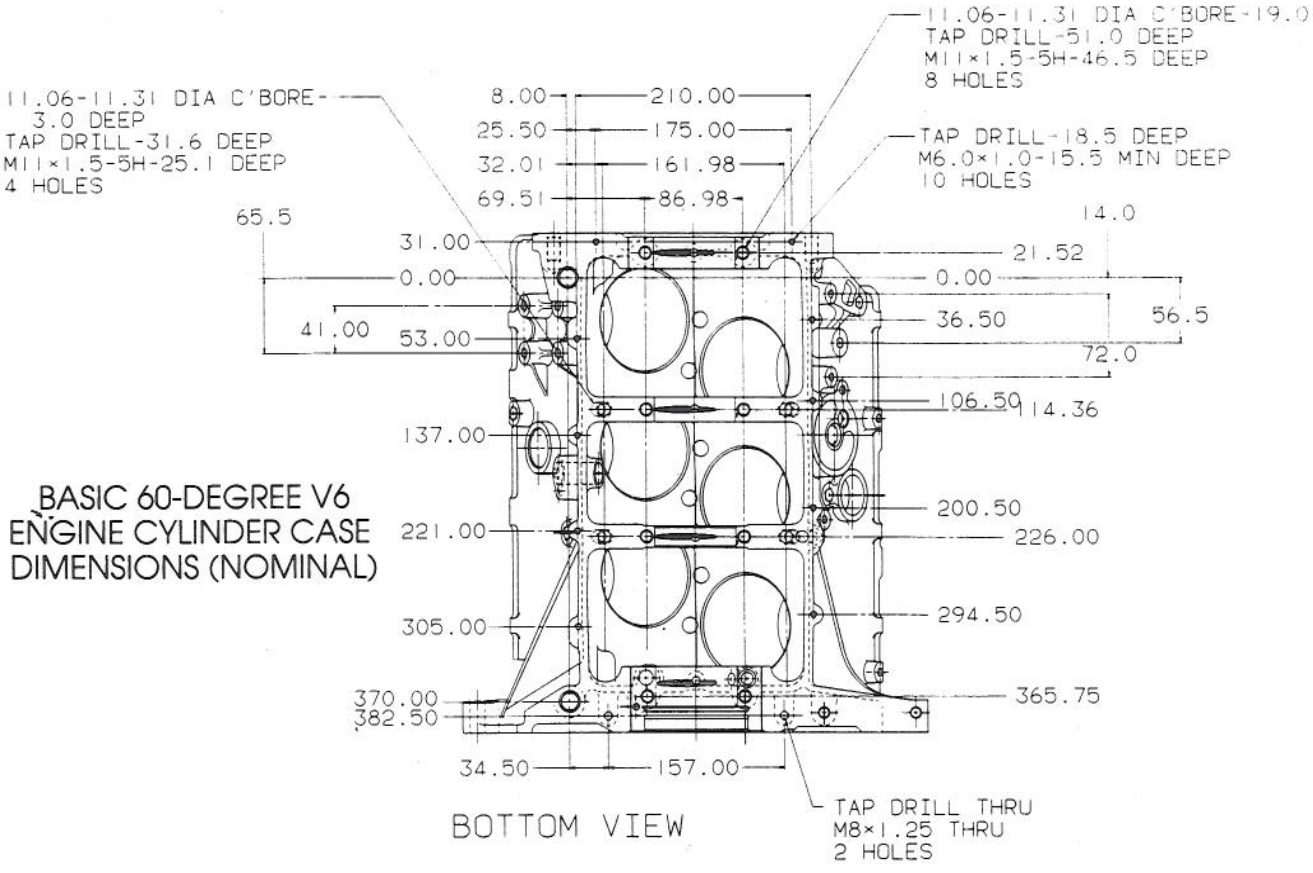
If new cam bearings are being installed, bearings from a small-block V8 may be substituted. These bearings are wider than production V6/60 cam bearings, so make sure that the longitudinal position is correct. The oil feed hole in the cam bearings should be positioned between 4 o'clock and 5 o'clock when viewed from the front of the block.



FRONT VIEW

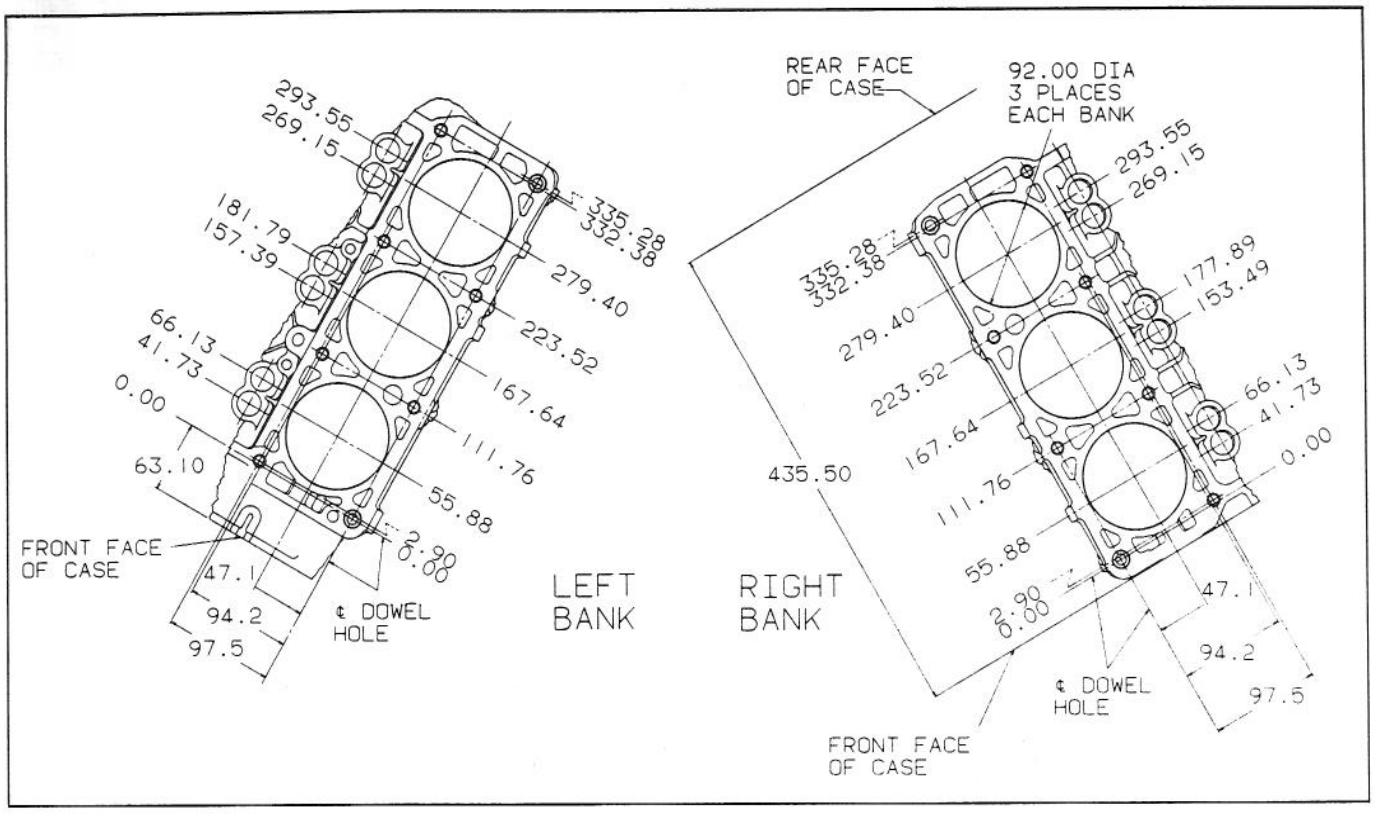


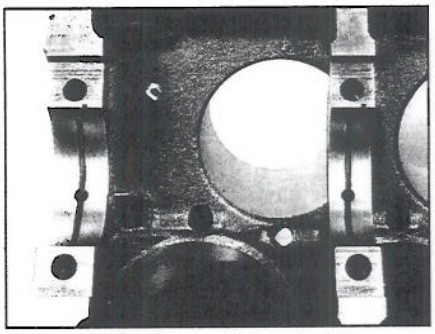
REAR VIEW



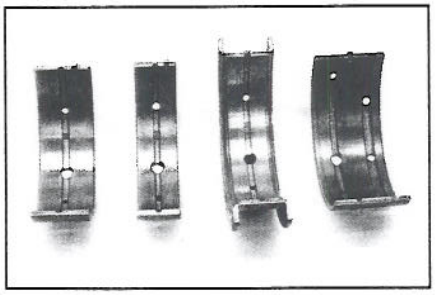
BASIC 60-DEGREE V6 ENGINE CYLINDER CASE DIMENSIONS (NOMINAL)

BOTTOM VIEW





Early-model V6/60 iron blocks should be modified to improve rod bearing oiling by machining grooves in the main bearing saddles.



Drill additional oil feed holes in the upper main bearing inserts to ensure that full oil pressure reaches the rod bearings.

The GM Motorsports Technology Group recommends an oiling system modification for pre-1985 V6/60 engines that are operated for sustained periods above 7000 rpm. This modification, which improves connecting rod oiling at high speeds, is already incorporated in production V6/60 blocks with large journal main bearings and all heavy-duty Bow Tie blocks.

The main bearing bores (in the block only) should be grooved through the oil hole with a slot .125-inch wide and .125-inch deep. This groove should extend 180 degrees on the front three main bearing saddles; on the rear main bearing bore, this groove should extend approximately 135 degrees. It should intersect the oil feed hole from the cam bearing, but it must not connect to the main oil feed passage that also enters the rear main bearing bore.

Modify the upper main bearing inserts by drilling two equally spaced .125-inch diameter oil feed holes on both sides of the original oil hole. (On the rear main bearing, drill only one hole where the groove in the block does not extend up to the bearing cap mating surface). This will produce a total of five oil holes in each upper bearing half (four holes in the rear bearing). This bearing modification ensures that full oil pressure reaches the connecting rod journal oil hole whenever it is exposed to the main bearing oil groove as the crankshaft rotates.

Crankshafts

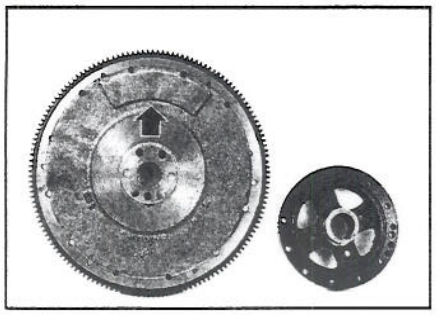
Production V6/60 crankshafts are cast nodular iron. The six crankpins and the center main bearing journals have deep rolled fillets that increase the crankshaft's fatigue life.

Crankshafts with two different main journal diameters have been installed in Chevrolet V6/60 engines. Engines produced in 1980-84 have 63mm main bearings, while most 1985 and later engines have 67mm mains. Production V6/60 nodular iron crankshafts with 67mm main bearings are extremely durable and have performed without failure in many racing applications.

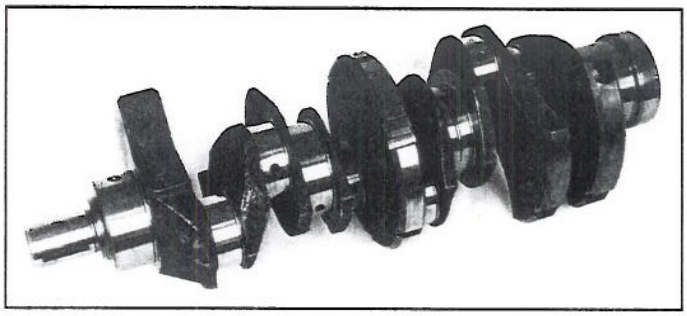
V6/60 crankshafts manufactured through the 1986 model year are externally balanced and require a counterweighted flywheel or flexplate for proper engine balance. In 1987, a new crankshaft with an integral timing disc was introduced in 2.8-liter engines with aluminum cylinder heads. Crankshafts with timing discs are internally balanced, and do not require a counterweighted flywheel.

This slotted timing disc provides reference signals for an electronic control module in the ignition coil assembly in production front-wheel-drive applications. The timing disc can be recontoured to serve as a crankshaft counterweight in V6/60 racing engines. The disc should not be modified, however, if you intend to use a block-mounted ignition sensor.

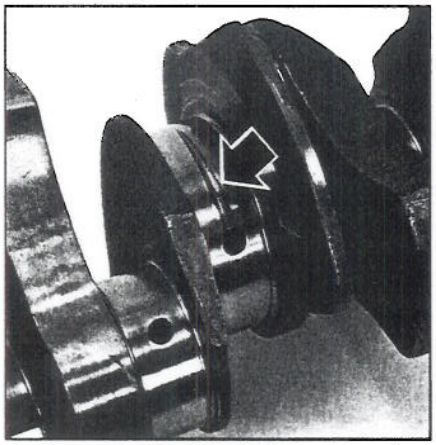
The GM Motorsports Technology Group recommends cross-drilling the



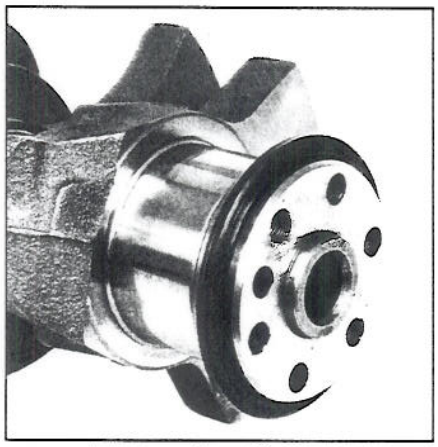
Externally balanced V6/60 crankshafts use counterweighted flywheels and neutral balanced torsional dampers.



A late-model production V6/60 crankshaft has an integral slotted timing disc that triggers the ignition system.



Lead-in grooves in the main bearing journals channel oil to the rod bearing oil feed holes in late-model V6/60 crankshafts.



1985 and newer cranks with large 67mm main bearing journals and one-piece oil seals are recommended for competition V6/60 engines.

center two main bearing journals on V6/60 crankshafts used in competition engines. This modification provides additional oil flow to the connecting rod bearings at high engine rpm. After drilling the journals, chamfer and deburr the holes at the bearing surfaces and inspect the oil holes for metal chips.

Production V6/60 crankshafts used in 1987 and later front-wheel-drive engines have lead-in grooves in the main bearing journals that channel oil to the feed holes for the rod bearings. All other V6/60 crankshafts should be modified for competition by machining similar lead-in grooves in the main journals. These lead-in grooves should start approximately ½-inch before the rod feed holes, tapering to a depth of .125-inch and a width of .200-inch. When polishing the journals after this machining operation, turn the crankshaft in the direction of normal rotation.

All 1980-84 and some 1985 Chevrolet 2.8-liter V6/60 engines used a rope rear main bearing seal. A one-piece neoprene lip seal that fits into the rope seal groove without modification is available as PN 14081761. This lip seal is more dependable than the rope seal, and is recommended for all high-performance V6s. 1985 and later V6/60 engines with large diameter main bearings use a one-piece rear main seal (PN 14085829).

Flywheels

The mass required to internally balance some 2.8-liter engines could not be included in the rear crankshaft counterweight due to limited clearance in the engine block. All 1982-87 rear-wheel-drive V6/60 engines and all 1980-86 front-wheel-drive V6/60s are externally balanced. These engines require a counterweighted flywheel or flexplate for proper crankshaft balance. 1987 and later V6/60 engines installed in front-wheel-drive vehicles are internally balanced, and use neutral balanced flywheels.

The flywheel or flexplate and its counterweight is an integral part of the balance system in externally balanced V6/60 engines. If an externally balanced crankshaft is rebalanced, or if your particular application requires a special flywheel or flexplate, these components must be balanced with the crankshaft. Alternatively, an externally balanced crankshaft can be internally balanced by adding slugs of heavy metal to its rear counterweight. These slugs of metal should be located horizontally (parallel to the crankshaft centerline) so that centrifugal force will not dislodge them. A crank which has been internally balanced with heavy metal requires a neutral balanced flywheel or automatic transmission flexplate.

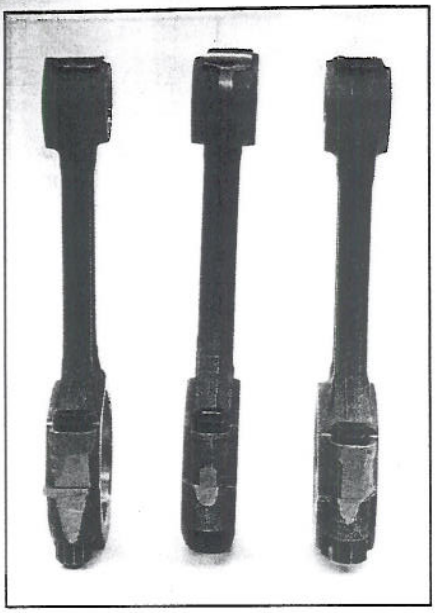
V6/60 engines used in midget race cars and other applications that do not normally use a flywheel should use an internally balanced crankshaft. If an internally balanced crank is not available, a bobweight can be sandwiched between the crankshaft and driveshaft connector to achieve the proper engine balance. (In applications where no flywheel is used, the harmonic damper's outer inertia ring should be removed. The damper hub can then be marked for timing the engine's spark advance.)

When balancing a V6/60 crankshaft, calculate the bobweight using 50 percent of the engine reciprocating weight and 100 percent of the rotating weight.

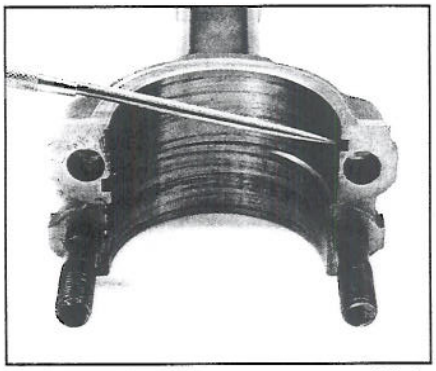
Connecting Rods

Production forged steel V6/60 connecting rods are heat-treated at the factory. These connecting rods are suitable for high-performance and limited competition applications when engine speeds do not exceed 7000 rpm.

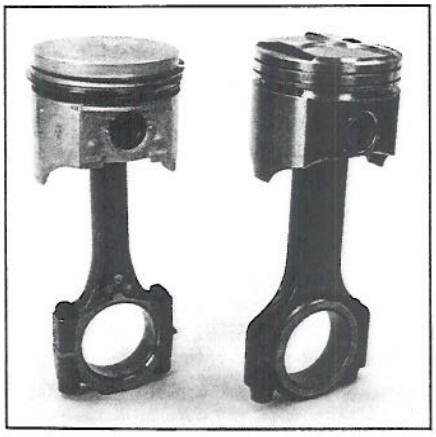
If you are building a competition V6/60 Chevrolet on a limited budget, engine durability can be improved by installing production connecting rods used in 1967 and earlier small-block Chevrolet V8s. Although some machining is required for this conversion, the total expense is typically less than the cost of aftermarket connecting rods. These "small journal" V8 rods have the same center-to-center length (5.70-inch) and the same rod bearing ID as production V6/60 rods. The small-block V8 rods have wider, thicker beams than stock V6/60 rods, and use $^{11}/_{32}$-inch bolts instead of the V6's standard 9mm (.354-inch) fasteners.



A production V6/60 rod (left) is reliable to 7000 rpm; a small-block V8 rod (center) can be narrowed to fit a V6/60 crankshaft. A small-block V8 rod (right) has the same bearing bore and center-to-center length as a V6/60 rod.



Machine new bearing tang grooves in modified small-block V8 rods to center the bearing inserts on the V6/60's rod journal.



Production connecting rods and cast aluminum pistons (left) are suitable for moderate performance applications. Aftermarket steel connecting rods and Chevrolet heavy-duty pistons (right) are recommended for racing.

TECH SPECS: V6/60 HIGH-PERFORMANCE PISTONS

Part Number	Engine	Compression Ratio	Size	Pin Type	ID#	Notes
14033129	2.8L	9:1	Standard	Pressed	14033123 or 14031340	High Output piston. Piston OD 88.961–88.999mm.
14033131	2.8L	9:1	+0.5mm	Pressed	14033125	High Output piston. Piston OD 89.474–89.525mm.
14033132	2.8L	9:1	+1.0mm	Pressed	14033127	High Output piston. Piston OD 89.974–90.150mm.
14044833	2.8L	12.5:1	Standard	Floating	14044829	Heavy-duty off-highway piston. Use with cast iron heads.
14044834	2.8L	12.5:1	+0.5mm	Floating	14044830	Heavy-duty off-highway piston. Use with cast iron heads.
14044835	2.8L	12.5:1	+1.0mm	Floating	14044831	Heavy-duty off-highway piston. Use with cast iron heads.

One important difference between V6/60 and small-block V8 connecting rods is the diameter of their wrist pin holes. V6 rods have .912-inch diameter pin bores; V8 rods have .927-inch wrist pin holes. In order to use V8 rods with stock or heavy-duty Chevrolet V6/60 pistons, the small ends of the V8 rods must be bushed to fit the V6 wrist pins. (If aftermarket pistons are ordered with .927-inch diameter wrist pins, the small-block rods will not require bushings.)

The big ends of the V8 rods must also be narrowed from .940-inch wide to .854-inch wide to fit the V6/60 crankshaft journals. Machine .086-inch off the side of the big end bore which is next to the crankshaft cheek in a V8 installation. Then machine new bearing tang notches in the rod, taking care to center the bearing insert on the rod journal. See the engine building chapter for additional information on connecting rod preparation.

V6/60 Chevrolet engines used in endurance racing and long-distance off-road events should be equipped with aftermarket connecting rods designed specifically for competition. V6/60 connecting rods are dimensionally similar to small-block V8 rods, so racing connecting rods are readily available from several aftermarket sources. The manufacturer's recommendations on bolt torque and rod installation procedures should be followed to ensure satisfactory service.

Pistons

Both standard and High Output versions of the V6/60 Chevrolet equipped with cast iron cylinder heads use flat-top pistons. These cast aluminum pistons are an "autothermic" design which provides uniform clearances through a wide range of engine operating temperatures. Pistons installed in High Output engines have a .020-inch taller compression height than standard V6/60 pistons. This change raises the compression ratio from 8.5:1 in standard 2.8-liter engines to 8.9:1 in H.O. and fuel-injected motors.

1987 and later "Generation II" V6/60 Chevrolets with aluminum cylinder heads use dished pistons. This sump head design maintains an 8.9:1 compression ratio with the aluminum head's smaller combustion chamber volume (28cc). Flat-top pistons used in 3.4-liter DOHC V6/60 engines have machined valve reliefs.

Chevrolet offers heavy-duty forged pistons with 12.5:1 compression for 2.8-liter V6/60 engines used in off-highway applications. Heavy-duty V6/60 pistons

are machined for 1.5mm (.059-inch) wide compression rings; these rings provide an effective seal at high speeds and reduce internal friction.

Heavy-duty Chevrolet forged aluminum V6/60 pistons should be used only with cast iron cylinder heads. Their dome design is not compatible with an aluminum head's splayed valves and heart-shaped combustion chambers.

Chevrolet heavy-duty pistons use round wire pin locks that are more resistant to pound-out than other pin retaining systems. The full-floating wrist pins supplied with these pistons are chamfered on both ends to accommodate these round wire pin locks. Replacement 1.07-inch OD x .064-inch round wire retainers (PN 14011033) are available for rebuilds. Wrist pin retainers should never be reused when an engine is rebuilt.

Heavy-duty Chevrolet pistons may require machining to provide valve clearance for long duration camshafts. The piston valve reliefs should correspond to the valve layout in the cylinder heads. A complete V6/60 piston set consists of *four* pistons with valve reliefs matching the No. 1 combustion chamber (used in cylinder Nos. 1, 3, 4, and 6), and *two* pistons corresponding to the No. 2 combustion chamber's layout (cylinder Nos. 2 and 5).

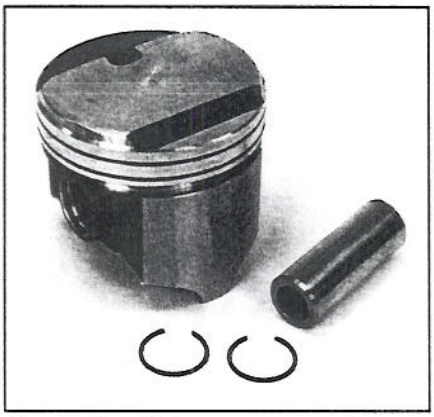
Piston Rings

Chevrolet markets high-performance piston ring sets for heavy-duty V6/60 pistons. These sets include 1.5mm (.059-inch) wide moly-filled compression rings with radiused faces. They are offered in standard, .5mm oversize, and 1mm oversize diameters for 89mm (3.50-inch) cylinder bores.

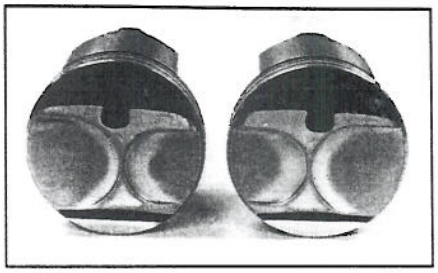
Measure the piston ring end gaps before installation with each ring square in its assigned cylinder bore. If the end gaps are under the minimum recommended dimension (.016-inch top, .014-inch second, .014-inch oil), the end gaps must be filed to prevent ring scuffing.

Cylinder Heads

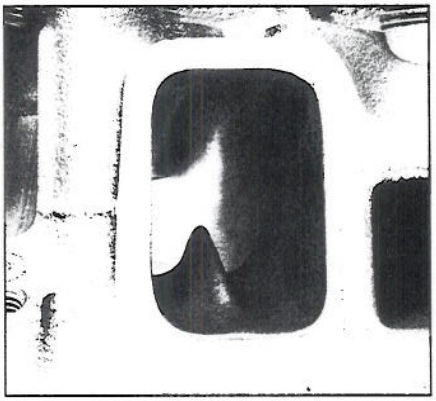
Cast iron and aluminum cylinder heads are used on production V6/60 Chevrolet engines. All 1980-86 front-wheel-drive and 1982 and newer rear-wheel-drive V6/60 engines are equipped with cast iron cylinder heads; 1987 and later "Generation II" and DOHC front-wheel-drive V6/60s have aluminum cylinder heads. Cast iron and aluminum heads are not interchangeable due to differences in the combustion chamber design and valve geometry of the two castings.



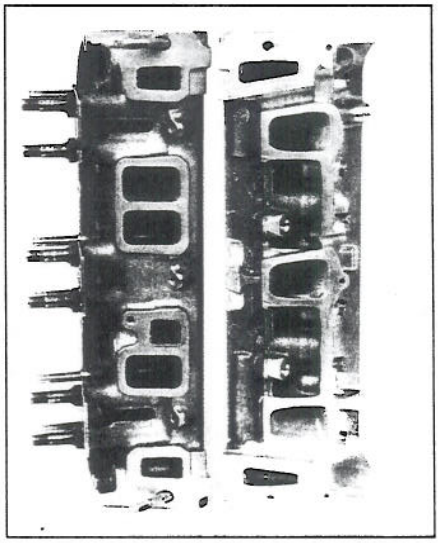
Chevrolet forged aluminum pistons with 12.5:1 compression are supplied with chamfered wrist pins and round wire pin locks.



Make sure the pistons' valve notches match the cylinder head layout when machining reliefs for valve clearance.



Production V6/60 cast iron cylinder heads have vanes in the intake runners that increase airflow. These vanes should not be removed.



A cast iron V6/60 head (left) has two siamesed intake ports; the ports in a Generation II aluminum head (right) are equally spaced.

Cast Iron Cylinder Heads

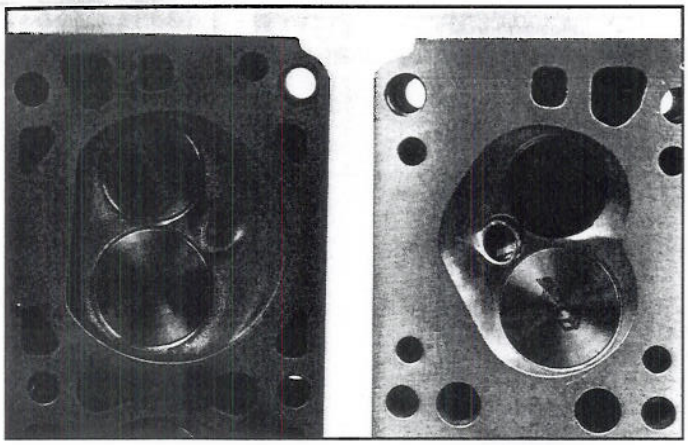
Several cast iron cylinder head assemblies have been used on production V6/60 engines. Heads installed on standard performance V6s have 1.60-inch diameter intake valves and 1.30-inch exhaust valves. High Output and fuel-injected versions are equipped with 1.72-inch diameter intakes and 1.42-inch exhausts. The larger valves of the H.O. cast iron cylinder head (PN 14054884) provide an increase in airflow over the standard head, and are preferred for competition V6/60 engines. The only difference between the standard and H.O. cast iron heads is the size of the valves; the ports and combustion chambers are the same in both cylinder heads.

Cast iron V6/60 cylinder heads were designed for production applications, and extra material was not included in the port walls to allow extensive enlargement of the runners. Nevertheless, V6/60 racing engines with production cylinder heads are capable of producing over 1.5 horsepower-per-cubic inch.

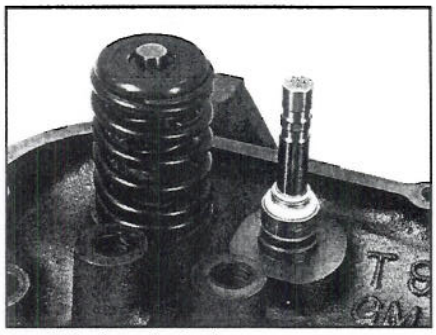
Production V6/60 intake runners have a "vane" in the port floor. This vane produced a 17 percent increase in airflow over a conventional port design, and should be retained in competition-prepared cast iron cylinder heads. The intake port entrances should be matched to the intake manifold gasket and casting irregularities removed from the port walls. Blend the sharp edges and machined steps in the valve bowl to form a smooth approach to the valve seat. Contour the exhaust valve bowl to form a smooth venturi under the valve seat.

Cast iron V6/60 cylinder heads have four-angle valve seats. This seat design provides optimum airflow, and should be retained in heads which have been modified for competition use.

V6/60 cylinder heads should be milled as little as possible to prevent a mismatch between the intake manifold ports and the



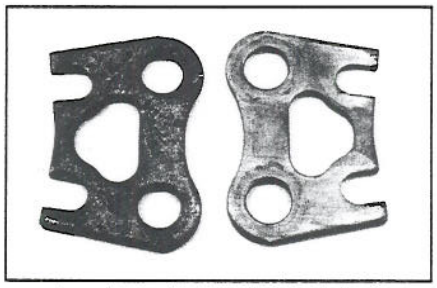
A cast iron head (left) has in-line valves and open-style combustion chambers; an aluminum head (right) has splayed valves and shallow heart-shaped chambers.



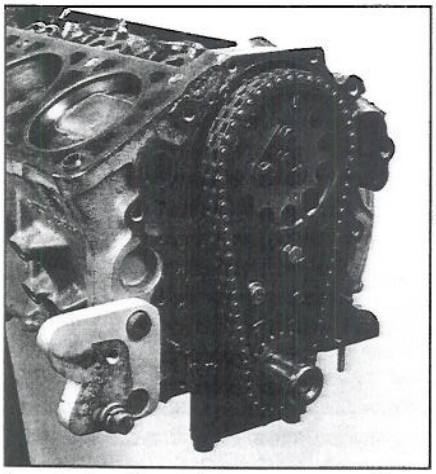
Small-block V8 dual valve springs (PN 330585) and aluminum retainers can be installed on modified cast iron V6/60 cylinder heads.

TECH SPECS: V6/60 CAMSHAFTS

Part Number	Description	Crankshaft Duration @ Lash Point, Int./Exh. (degrees)	Crankshaft Duration @ Tappet Lift, Int./Exh. (degrees)	Maximum Lift w/ 1.5:1 Rocker Ratio, Int./Exh. (inches)	Valve Lash	Lobe Centerline (degrees)	Notes
14024278	Hydraulic flat tappet	258/276	178/196	.347/.394	N/A	107	Base 2.8L V6, S-10 and Camaro.
14034378	Hydraulic flat tappet	276/293	196/203	.394/.410	N/A	109	High-performance 2.8L



A stock V6/60 pushrod guideplate (left) fits 11mm rocker arm studs. Holes must be enlarged to fit 7/16-inch big-block studs.



A production silent link timing set is suitable for competition V6/60 engines. Use a thrust bearing to limit cam movement.

rocker cover gasket surface. Milling the head more than the minimum required to straighten the deck surface may reduce head gasket clamping and lead to premature gasket failure because the V6/60 has only four head bolts around each bore.

Aluminum Cylinder Heads

Lightweight aluminum cylinder heads were introduced in 1987 on "Generation II" 2.8-liter V6/60 engines installed in Celebrity, Corsica, Beretta, and Cavalier front-wheel-drive chassis. Production aluminum V6/60 cylinder heads incorporate a heart-shaped "fast burn" combustion chamber with splayed valves. The size and shape of the inlet port and the shrouding around the intake valve seat direct the incoming air/fuel mixture in a concentrated stream. This stream promotes swirl in the combustion chamber and spreads the flame front quickly to all parts of the chamber. The resulting fast combustion produces a smooth but rapid rise in cylinder pressure. The spark plug is also centrally located in the combustion chamber to promote propagation of the flame front throughout the chamber.

The intake and exhaust valves are canted relative to each other and to the head's deck surface. This splayed-valve design is similar to a big-block Chevrolet V8; it promotes efficient breathing by unshrouding the valve heads as lift increases. Production aluminum V6/60 heads have 1.72-inch diameter intake valves and 1.42-inch exhaust valves. Valve stem diameter is 8mm (.315-inch).

Valvetrain

Valve timing for standard production and H.O. V6/60 hydraulic lifter camshafts are listed in the specifications chart.

Several aftermarket manufacturers offer camshafts that are suitable for high-performance and competition V6/60 engines. As a general guideline, a good street hydraulic cam for the 2.8-liter V6 should have approximately 205 to 210 degrees of intake duration at .050-inch tappet lift and 215 to 220 degrees exhaust duration at .050-inch tappet lift. A mechanical lifter cam with 270/280 degrees intake duration and 275/280 degrees exhaust duration is recommended for most competition applications. Maximum valve lift should be approximately .560-inch. Street and competition cams should be ground with lobe centers between 106 and 110 degrees.

Valve Lifters

Some types of mechanical lifters cannot be used in V6/60 Chevrolets due to the design of the production lubrication

system. The left-hand lifter oil gallery in production engine blocks also feeds the crankshaft bearings. It is larger in diameter than the right lifter gallery and offset from the lifter bore centerline. Since this gallery also supplies lubrication to the main and connecting rod bearings, it cannot be restricted like a V8 gallery to control overhead oil flow. (Aluminum Bow Tie V6/60 blocks have V8-style oil systems with three oil galleries. The oil flow to the lifter galleries can be restricted when roller bearing rocker arms are used without reducing the oil supply to the crankshaft bearings.)

Production V6/60 engines equipped with mechanical lifter cams require a piddle valve lifter. Chevrolet mechanical lifter PN 5232695 is not suitable for V6/60 engines due to oil leakage around its pushrod seat. Sealed Power lifter PN AT-992 is satisfactory for V6/60 engines equipped with mechanical tappet cams.

Before installing new lifters in an aluminum block, deburr or sand off any sharp edges in the grooves around the lifter bodies. These edges tend to gall and wear the aluminum lifter bores rapidly.

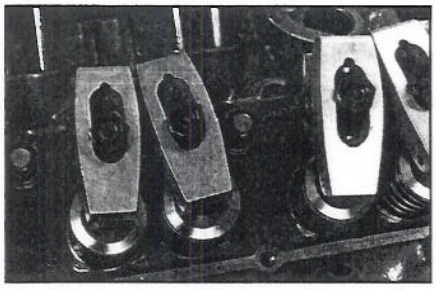
Valve Springs

Production V6/60 valve springs and retainers are satisfactory for hydraulic camshaft profiles with .420-inch or less maximum valve lift. Chevrolet dual valve spring PN 330585 and aluminum retainer PN 330586 can be used with mechanical cams with .560-inch or less net valve lift. This spring is 1.379-inch in diameter, and produces 135 pounds of seat pressure at an installed height of 1.72-inch. V6/60 cylinder heads must be modified to accommodate this spring by enlarging and deepening the valve spring pockets. Install aftermarket valve stem seals for oil control when using these springs.

Rocker Arms

Production V6/60 stamped steel rocker arms are mounted on individual rocker studs with pivot balls and adjusting nuts. This lightweight, rugged valvetrain is similar to the small-block Chevrolet V8. Production V6/60 valvetrain components are suitable for many applications.

The reliability of a V6/60 engine equipped with racing valve springs can be improved by installing 7/16-inch diameter big-block V8 rocker arm studs (PN 3921912). To perform this conversion on cast iron V6/60 cylinder heads, the stock studs must be removed and the 11mm



Check for interference between adjacent rocker arms when using aftermarket needle bearing rockers on V6/60 cylinder heads.

rocker arm stud holes drilled and tapped with 7/16-14 threads. The rocker stud bosses will have sufficient strength to support the big-block rocker studs after they are re-tapped.

The pushrod guideplate holes must also be enlarged slightly to fit the 7/16-inch studs. The guideplates are hardened, so the holes should be enlarged by grinding or drilling with a carbide drill bit.

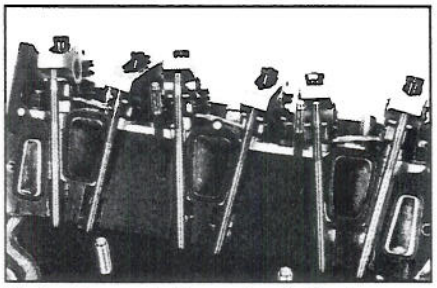
Aftermarket needle bearing rocker arms for a small-block V8 with 7/16-inch trunions should be installed on cast iron V6/60 cylinder heads that have been converted to 7/16-inch rocker studs. Due to limited clearance between adjacent rockers, narrow aluminum rockers are required. Aftermarket rocker arms with 1.260-inch wide trunions (Crane PN 11756 or equivalent) are suitable.

Head Gaskets

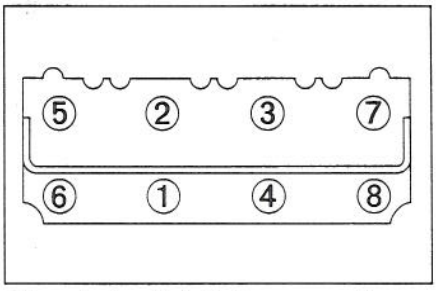
Head gasket sealing is critical on V6/60 engines because the block has only four head bolts around each cylinder bore. The span between bolts is relatively short, however, and V6/60 Chevrolet racing engines seldom experience problems with leaking head gaskets.

The block and cylinder head surfaces should be as straight as possible to promote an effective seal. Only the minimum amount of material necessary to straighten the sealing surfaces should be removed when machining the decks.

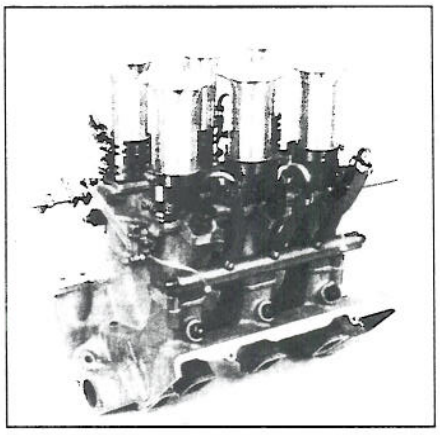
Cast iron blocks used for endurance racing should be machined for .041-inch stainless steel "O"-rings and assembled with .035-inch thick production head gaskets. The outer diameter of the "O"-ring groove should be 3.750-inch, and the wire should protrude .005 to .007-inch above the deck surface. Modify the production head gasket by enlarging the small water passage holes for the end cylinders to 9/32-inch diameter. Enlarge the two center water holes to 1/4-inch.



The intake ports in Generation II aluminum cylinder heads are tapered to provide pushrod clearance. Splayed valves improve breathing.



Tighten the head bolts in the sequence shown when installing or retorquing V6/60 cylinder head gaskets.



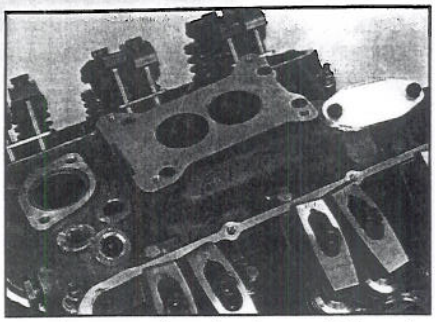
Aftermarket fuel injection manifolds are available for cast iron and Generation II aluminum V6/60 cylinder heads.

Install the head gasket without sealer. Tighten the head stud nuts to 65 ft.-lbs., and retorque the head studs after the engine has been run.

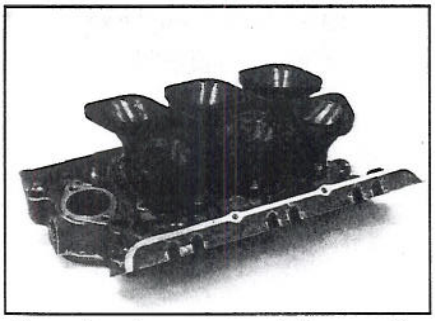
Intake Manifolds

The location of the intake manifold water outlet is different on V6/60 engines used in front-wheel-drive and rear-wheel-drive chassis. Make sure that the manifold's water outlet is in the correct location for your vehicle.

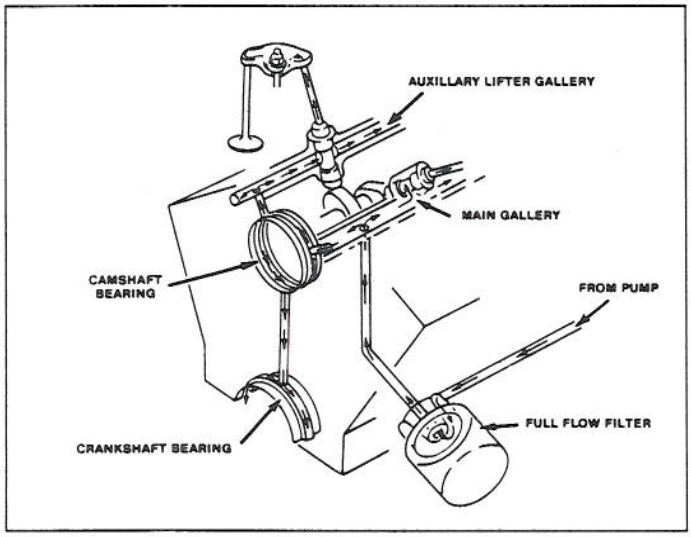
Induction systems for production Chevrolet V6/60 engines range from two-barrel carburetion to multi-point



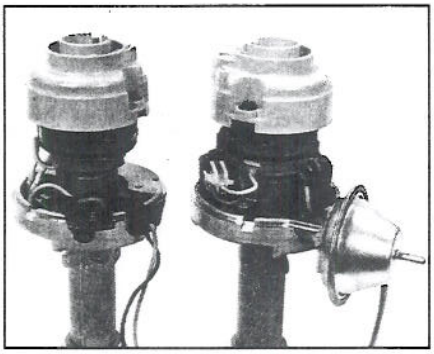
A production two-barrel intake manifold can be modified with an adapter plate to mount a 500cfm Holley carburetor.



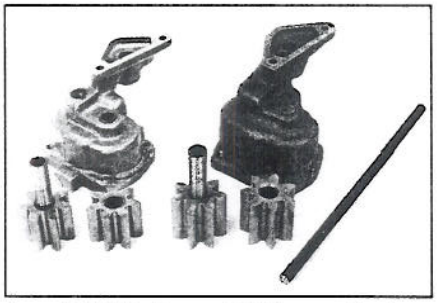
Aftermarket adapters are available to install three downdraft Weber two-barrel carburetors on a fuel injection manifold.



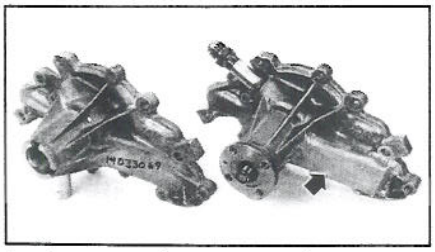
The production V6/60 lubrication system uses two galleries. Oil is routed to the main bearings through the left-hand gallery.



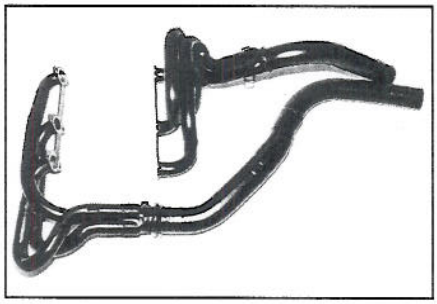
Eliminate the vacuum advance and connect the magnetic pickup in an S-10 distributor directly to a heavy-duty ignition box for racing.



A stock V6/60 oil pump (left) has an aluminum housing; a high-volume pump (PN 10051104–right) has a cast iron housing and longer gears.



An aluminum V6/60 water pump housing can be modified to increase coolant flow by enlarging its inlet passage.



A three-into-one header system with 1⅝-inch primary pipes is recommended for competition Chevrolet V6/60 engines.

electronic fuel injection. Several aftermarket manufacturers also offer competition intake manifolds for V6/60 engines.

A production two-barrel manifold will perform well in restricted racing classes. Install an adapter for a Holley two-barrel, plug the EGR passages, and enlarge (or remove) the stock throttle bores.

Lubrication System

Production Chevrolet V6/60 oil pumps have lightweight aluminum housings. Oil pressure is regulated by a bypass spring located in the oil pump cover. A high-pressure spring (PN 10044435, color coded with a blue stripe) will produce approximately 70 psi oil pressure.

Remove and discard the gasket between the cover and pump body. Machine the ends of the pump gears to produce .001 to .002-inch clearance between the gears and the pump cover.

A heavy-duty cast iron oil pump for the V6/60 is available as PN 10051104. This pump has longer gears than a production pump, and offers a significant increase in oil volume for competition V6/60 Chevrolets. Modify this pump by enlarging the hole between the pickup and the pressure bypass to .410-inch diameter; a larger plug is required after drilling out this hole. The hole in the pump cover that feeds the oil pressure relief should also be enlarged to .410-inch. Relocate the pin that retains the oil pressure relief spring to the edge of the pump cover, and install a low-pressure Weaver pump spring (color coded green) with a .050-inch spacer. A cast iron oil pump modified in this manner will provide a steady supply of oil at approximately 80 psi.

Chevrolet does not offer windage trays for V6/60 oil pans. However, a semi-circular small-block V8 tray (PN 3927136) can be modified for use in a V6/60 by cutting off the front section. Three main cap bolts must also be modified by welding mounting studs to the bolt heads. The length of these mounting studs should be adjusted to provide sufficient clearance for the oil pan, crankshaft, and connecting rods you are using.

Ignition System

Production V6/60 engines are equipped with HEI (High Energy Ignition) systems. The spark timing in 1981 and later passenger cars equipped with V6/60 engines is controlled entirely by the vehicle's electronic control module.

1982-84 S-10 pickups and Blazers used conventional mechanical and vacuum controls for spark timing. This conventional ignition system can be easily modified for racing and high-performance applications. S-10 truck distributors also have remote-mounted coils, and are recommended for installations that require a small diameter distributor cap.

Cooling System

The production V6/60 water pump is a lightweight aluminum casting with a rib-reinforced snout. This pump should be modified for endurance racing to increase coolant flow. Disassemble the pump and enlarge the water pump inlet by machining off the outside wall of the cast aluminum housing. Fabricate a new water inlet passage from sheet aluminum and weld it to the pump casting. This new inlet should be approximately twice as deep as the original passage. Radius the inlet where it joins the impeller chamber and remove the impeller dust collar.

Exhaust System

Cast iron exhaust manifolds from an S-10 truck can be used for engine swaps, street rods, and similar installations. A dual exhaust system with low-restriction Corvette mufflers and a cross-over pipe will perform well on high-performance V6/60 engines that are not subject to emission regulations.

The preferred exhaust system for a competition V6/60 Chevrolet is a three-into-one header system for each cylinder bank. Primary pipe dimensions of 1⅝-inch OD x 26 inches long feeding 2½-inch diameter collectors have proven successful. Tailpipe length should be at least 33 inches. If the engine operating range is above 4000 rpm, a 2¼-inch diameter crossover pipe between the two collectors may be beneficial. Position this crossover at the front of the collectors.

Header systems designed to these dimensions are available from specialty manufacturers and independent shops. These sources can supply specific information on tubing sizes and chassis considerations for your usage.

TECH SPECS: V6/60 SPECIFICATIONS FOR HIGH-PERFORMANCE USE

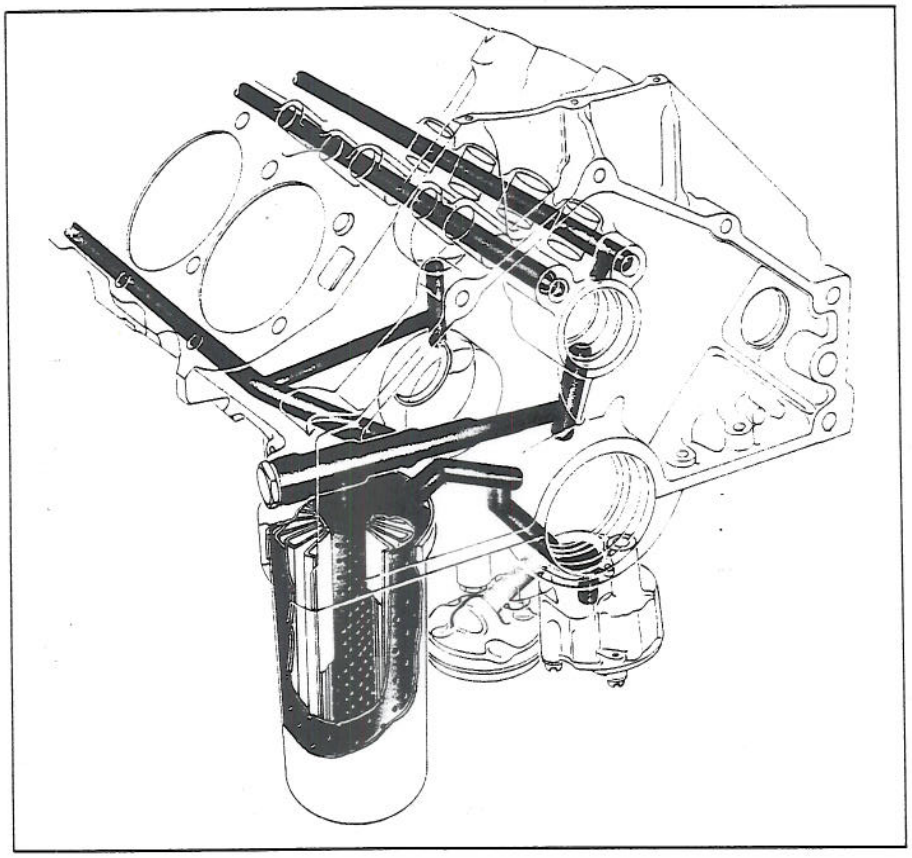
Firing Order	1-2-3-4-5-6
Spark Advance	Maximum 36-40° BTDC
Maximum Oil Temp	270° in oil pan
Minimum Fuel Pressure	4-5 psi at maximum engine speed
Piston to Bore Clearance	.006-.007" measured at centerline of wrist pin hole perpendicular to pin for Chevrolet heavy-duty forged pistons; .002-.003" for cast pistons. Follow manufacturer's recommendations for other pistons. Finish bores with 400 grit stones or equivalent.
Minimum Piston Ring End Gap	Top .016"; Second .014"; Oil Rails .016"
Wrist Pin Clearance	.0006-.0008" in piston; .0010-.0012" in rod (.0005-.0008" in bushed rod for floating pin, 0-.005" end play preferred)
Rod Bearing Clearance	.002-.0025"
Rod Side Clearance	.008-.012"
Main Bearing Clearance	.002-.0025"
Crank End Play	.004-.007"
Piston to Cylinder Head	.035" minimum (steel rods)
Valve to Piston Clearance	.045" for intake and exhaust at running valve lash. NOTE: These are absolute minimum clearances for an engine running below the valvetrain limiting speed. More clearance must be allowed for engines operating at valvetrain limiting speed; allow .080" intake and .100" exhaust valve clearance for high rpm engines.

NOTE: These specifications are intended as general guidelines for high-performance and competition applications. Different clearances and specifications may be required depending on operating conditions and components used. Always follow manufacturer's recommendations when installing aftermarket components.

NOTES:

Lubrication System

Mark IV oil pump

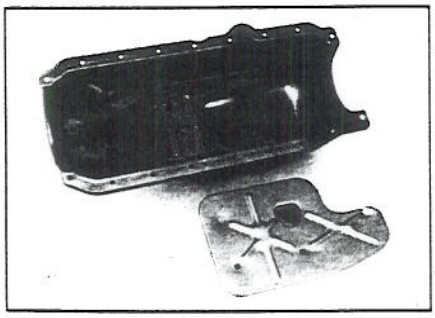


Oil is the lifeblood of every engine. Without a constant supply of clean oil, delivered at the proper pressure and the recommended temperature, an engine cannot survive the heat and stress of competition.

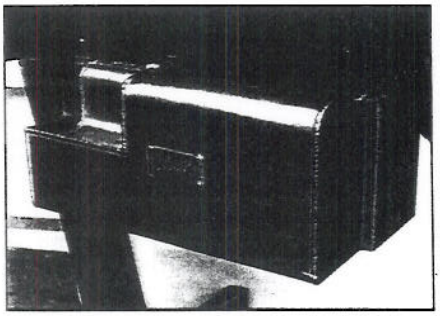
Oil both lubricates and cools internal components. It prevents metal-to-metal contact between moving parts, and transfers heat away from high-temperature areas. A properly designed and correctly installed lubrication system is essential to the health of any high-performance Chevrolet engine.

This chapter will describe the general requirements for an effective lubrication system. For specific information on recommended modifications for Chevrolet motors, refer to the sections on block preparation, crankshafts, and lubrication systems in the appropriate chapter.

There are two basic types of lubrication systems: wet sump and dry sump. In a wet sump system, the oil supply is stored in the pan; in a dry sump, it is held in an external reservoir or tank. The choice between a wet sump and dry sump lubrication system depends on both the engine builder's budget and the motor's intended usage. Dry sump systems are required in some racing classes and prohibited in others, so the rulebook may determine the final decision in many instances.



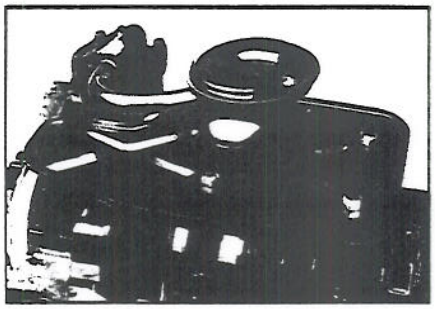
Baffles and windage trays can be installed in wet sump pans to control oil slosh under hard acceleration, braking, and cornering.



Aftermarket oil pans are available for racing classes that require wet sump systems. A deep, wide pan minimizes windage losses.

Wet Sump Oil Systems

All Chevrolet production engines use wet sump oil systems. A wet sump is simple, relatively inexpensive, and completely reliable in many high-performance applications. Wet sump oil systems are suitable for modified street engines,



Many high-performance Chevrolet engines are equipped with a windage tray to separate the oil in the sump from the crankshaft assembly.

pleasure boats, and many classes in both oval track and drag racing competition.

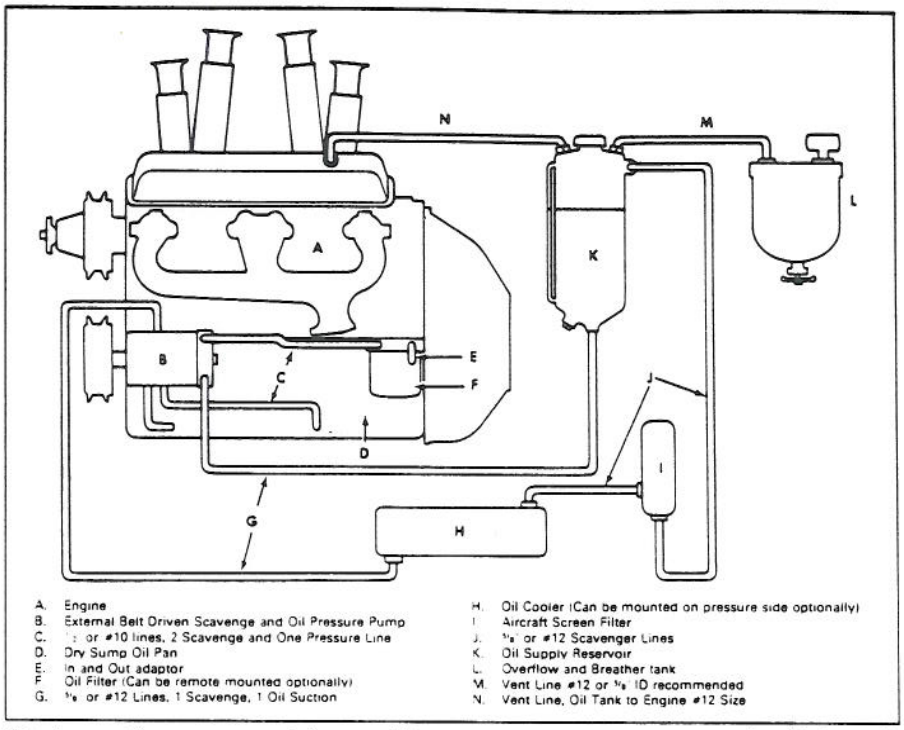
The chief shortcoming of a wet sump is oil control. During hard braking, acceleration, and cornering, the oil pump pickup may be uncovered, interrupting the flow of lubricant to the bearings. The oil in a poorly designed wet sump system can also be aerated by the rapidly spinning crankshaft assembly; the resulting air bubbles in the oil supply reduce its lubricating qualities.

Racing engines equipped with wet sump systems may have high internal friction caused by windage losses if the oil in the pan is not effectively separated from the crankcase. The restricted capacity of most production pan designs also limits the total engine oil supply to four or five quarts. In a long-distance event, the oil may become overheated unless an auxiliary cooler is used to maintain the recommended oil temperature.

A properly designed wet sump oil system can remedy many of these shortcomings. Baffles can be installed in the pan to reduce oil slosh and to keep the oil pump pickup covered. Oil pump pickups can be modified to ensure a constant flow of oil. Windage trays can be fabricated to separate the oil in the sump from the crankshaft assembly. Wet sump pans can be deepened and widened to increase their capacity, and auxiliary coolers can be added to keep the oil temperature within the recommended range.

Dry Sump Oil Systems

Dry sump oil systems avoid many of the pitfalls of the wet sump design. In a typical dry sump system, the oil is scavenged from the engine by an externally mounted pump and stored in a remote-mounted tank. The oil is drawn from this reservoir, filtered, and then pumped back into the engine.



This diagram illustrates a typical dry sump lubrication system. Scavenge stages can be added to pull oil from the lifter valley and heads.

A dry sump system has several advantages over a wet sump. The storage tank provides an ample supply of oil for the pressure pump regardless of the vehicle's attitude or cornering speed. The oil capacity can be several times greater than a wet sump. An efficient scavenging system reduces windage losses by minimizing the volume of oil inside the engine. A shallow dry sump oil pan also allows the engine to be mounted low in the chassis to improve handling. Many racing organizations require dry sump systems to limit the loss of oil onto the track surface in the event of a blown engine.

Dry sump oil systems do have drawbacks, of course. They are more expensive, more complex, and heavier than wet sumps. They require a pump drive, mounting brackets, hoses, and a storage tank. Nevertheless, the advantages of a dry sump oil system usually outweigh the disadvantages for a maximum-effort racing engine. Dry sump lubrication systems have become standard in stock car racing, road racing, offshore boat racing, and professional drag racing.

Dry Sump Design

The GM Motorsports Technology Group recommends the following procedures when selecting and installing dry sump oil system components:

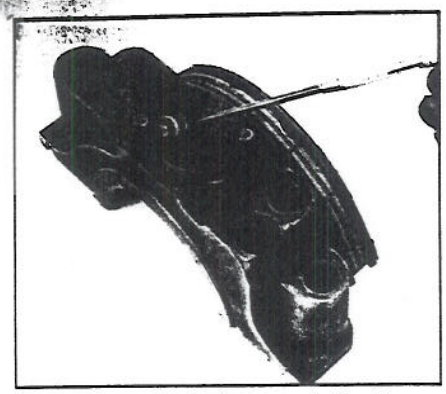
1. Eliminate the internal engine pump and plug the oil pump passage in the cylinder block. Install a non-bypassing in-and-out adapter on the oil filter pad.

2. Most dry sump oil pumps consist of a series of scavenge and pressure stages contained in a single belt-driven unit. The GM Motorsports Technology Group recommends a pump with at least two (and preferably three) scavenge stages, plus one pressure section.

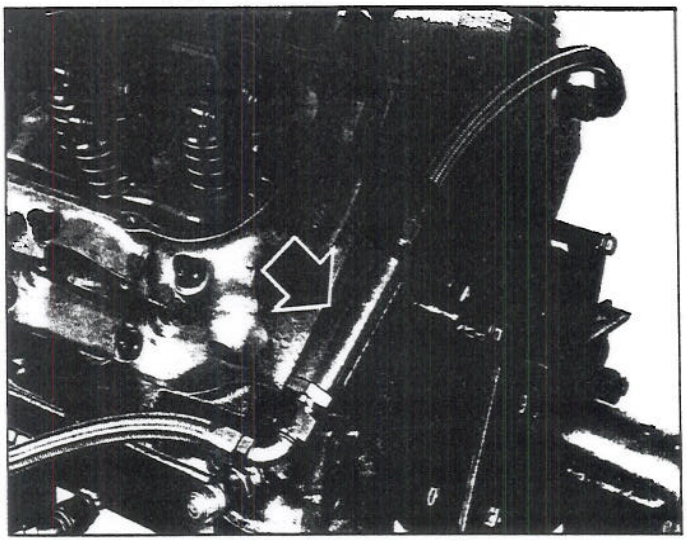
3. A minimum of two scavenge stages should be plumbed to the oil pan. If a third scavenge stage is used, it should be connected to the lifter valley or the rear of the valve cover on the outboard side of the car. (On oval tracks that are run in a counter-clockwise direction, the passenger side is outboard; on road courses, the predominantly outboard side depends on the course layout and the direction which the course is run.)

4. If the capacity of the oil pump scavenge stages is adequate, the scavenged oil can be pumped through an oil cooler before it is returned to the supply tank. This routing requires low-restriction coolers.

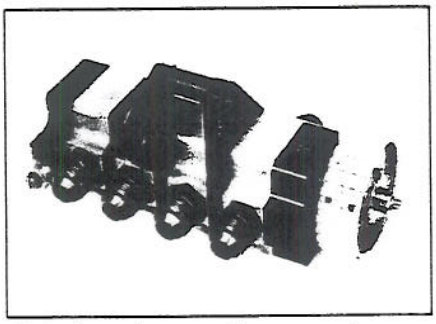
Oil coolers should not be connected in series; if more than one cooler is used, they should be plumbed in parallel. To connect coolers in parallel, install a tee fitting in the scavenge return line and route the oil through both filters simultaneously. The minimum recommended inside diameter for oil scavenge lines is ¾-inch (#12 hose).



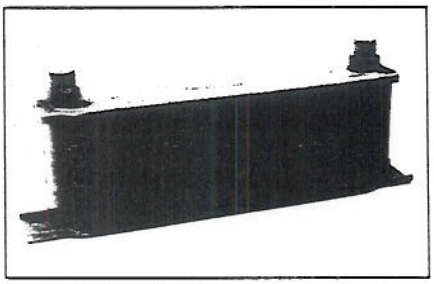
Remove the internal oil pump and plug the pump passage in the rear main bearing cap when converting a block to dry sump oiling.



Install screen-type filters in the scavenge lines to prevent metal particles from damaging the oil pump and contaminating the dry sump storage tank.



A belt-driven dry sump oil pump contains a series of scavenge and pressure stages. The oil pressure can be adjusted externally.



Low-restriction oil coolers can be installed in scavenge and pressure lines. Engine oil temperature should not exceed 270 degrees.

Install fine screen-type filters in the scavenge lines. These filters will prevent metal particles from reaching the supply tank, pressure pump, and pressure bypass valve. A screen-type filter should be examined frequently to check for bearing material and other debris that may indicate internal engine problems.

5. Use ¼-inch ID line (#12 hose) from the supply tank to the pressure stage of the oil pump.

6. Route the pressurized oil from the oil pump through a remote-mounted oil filter and then into the engine block. An oil cooler may be installed between the pressure pump and the remote oil filter. (See item No. 4 above for alternate oil cooler plumbing.) Use ½-inch ID line (#10 hose) for high pressure oil plumbing.

7. Excessive oil pressure will increase total oil flow through the engine and reduce the efficiency of the oil scavenging system. The minimum recommended oil pressure for Chevrolet racing engines is 65 psi. Many successful engine builders specify 10 psi oil pressure for every 1000 rpm. Using this formula, an engine running at 8000 rpm should have at least 80 psi oil pressure.

8. Install a full-length semi-circular windage tray baffle under the crankshaft. This tray should be louvered to draw oil away from the crankshaft assembly. The baffle can be mounted on the main cap studs or installed in the oil pan.

9. A round oil sump tank is recommended. This tank should be as small in diameter and as tall as the available space allows. It should have a minimum capacity of eight quarts when two-thirds full. The tank should have a cone-shaped bottom with the oil outlet to the pressure pump located at the bottom of the cone. This tank design assures that the oil outlet will be covered regardless of the g-loads the vehicle may encounter.

The scavenged oil should be returned at the top of the supply tank through a fitting which is tangent to the side of the tank. This will circulate the oil around the side of the tank, separating air from the scavenged oil. The tank should also incorporate a horizontal baffle perforated with 3/16-inch to ¼-inch diameter holes. This baffle design also de-aerates the oil, and stops the swirling of the lubricant.

The preferred location for the dry sump tank is in the engine compartment. This location minimizes oil line lengths.

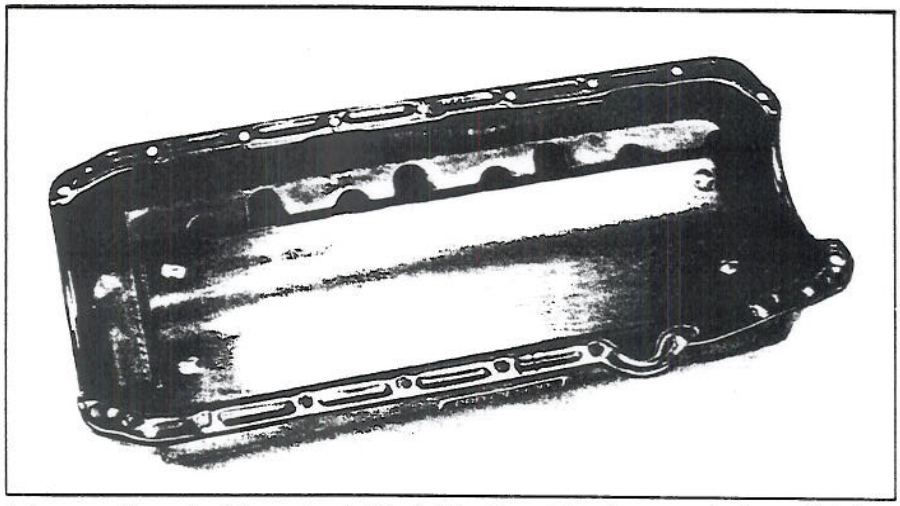
10. The engine should be assembled with the proper valve lifters, rocker arms, and bearing clearances to minimize oil flow. Reducing the engine's oil requirements is a tremendous advantage for a properly functioning dry sump system. Oil flow in a properly assembled competition Chevrolet V8 should be approximately eight gallons per minute. A V6's oil flow should be approximately six gallons per minute.

11. Both the engine and the supply tank should be vented to the atmosphere. The engine can be vented to the supply tank if the tank is properly vented. The vent lines must be large enough to prevent pressure build-up in the crankcase; a single #12 line or two #10 vent lines are recommended. The engine may be vented through existing breather holes in the rocker covers; install oil separators (baffles) to prevent oil from being pulled into the vent lines.

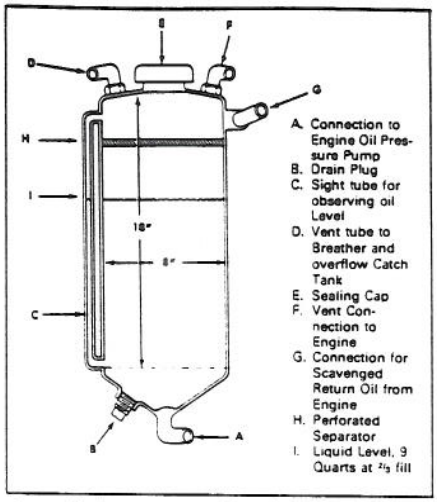
12. The oil pan should be as deep as the chassis design allows. (Some sanctioning bodies also enforce minimum ground clearance rules which should be observed when designing a dry sump oil pan.) It is easier to scavenge oil effectively from a six-inch deep pan than from a four-inch deep pan.

If the pan is equipped with two oil scavenge pickups, it should be divided in half. The pickups should be located at the rear of each compartment. Don't be concerned about how well the pan is scavenged under braking; it is unimportant how much power the engine produces when the driver is off the throttle.

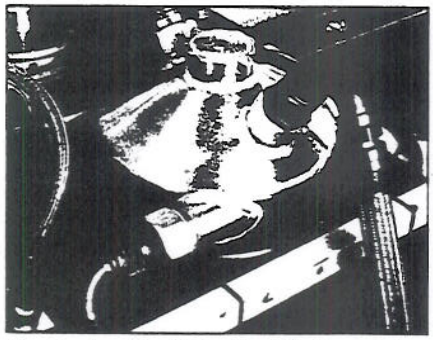
13. The GM Motorsports Technology Group recommends that screens *not* be used on the scavenge pickups. Many engines have been damaged and races lost



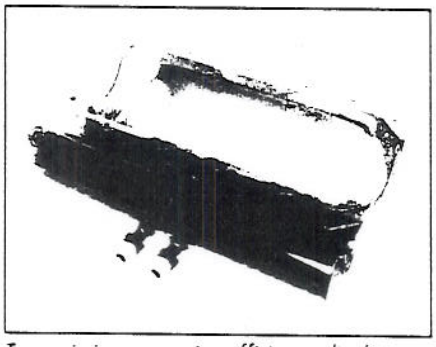
A dry sump oil pan should be equipped with a full-length, semi-circular tray under the crankshaft. Notch the oil scraper for connecting rod clearance.


A. Connection to Engine Oil Pressure Pump
B. Drain Plug
C. Sight tube for observing oil Level
D. Vent tube to Breather and overflow Catch Tank
E. Sealing Cap
F. Vent Connection to Engine
G. Connection for Scavenged Return Oil from Engine
H. Perforated Separator
I. Liquid Level, 9 Quarts at 2/3 fill

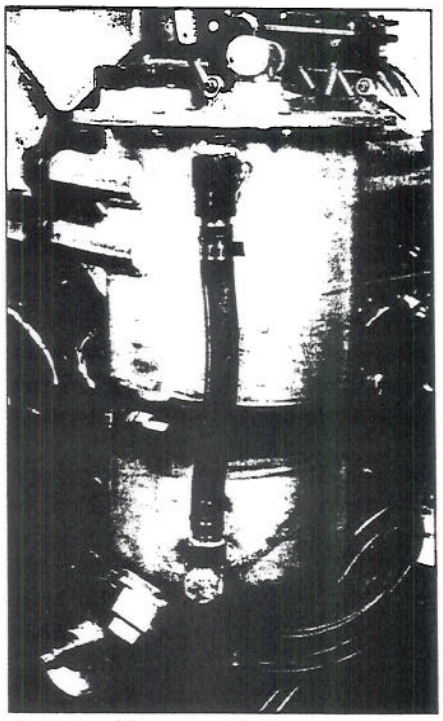
A round oil reservoir tank with a cone-shaped bottom is recommended.



The oil return line fitting should be tangent to the side of the dry sump reservoir tank to swirl and de-aerate the scavenged oil.



To maximize scavenging efficiency, divide a dry sump oil pan into two parts with baffles and use one pickup for each half of the pan.



Check the effectiveness of a dry sump system by observing fluctuations in the oil level in a sight gauge on the dry sump reservoir tank.

because scavenge pickups have been plugged by RTV, cork, and aluminum particles. To keep contaminants out of the scavenge sections, install screens over the oil drainback holes in the engine block. Magnets can also be installed near the oil drainback holes and in the rear of the oil pan to catch stray steel particles.

14. If possible, run the complete dry sump system on a dynamometer and observe fluctuations in the oil level with a simple sight gauge installed on the side of the sump tank. This will reveal the effectiveness of the oil pan, baffle, and scavenging system. There should be no more than a one or two quart drop in the oil level in the tank between idle and maximum engine speed.

A similar test of the dry sump system can be performed in the vehicle by shutting off and declutching the engine at high speed. Drain the oil pan to determine how much oil is circulating in the engine and crankcase at high rpm.

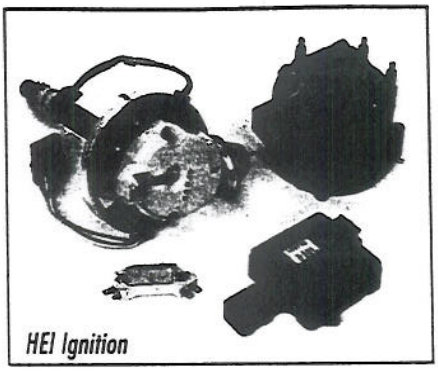
A dry sump oil system does *not* guarantee trouble-free engine lubrication. A dry sump system should be checked for proper operation, and maintained in peak condition. An oil pressure gauge should be installed to reveal any fluctuations in oil pressure, and the scavenging system tested to determine its efficiency.

Racing Oil

The GM Motorsports Technology Group recommends 30 to 50 weight ashless racing oil or a 20W-50 multi-viscosity oil with ashless detergent additives. If you are uncertain whether a particular brand of oil is ashless, check with the oil manufacturer. Avoid all oils that contain even a small percentage of barium or calcium. These materials promote destructive pre-ignition and can cause burned pistons when they are present in carbon deposits in the cylinder.

Synthetic oils have shown excellent performance at high engine temperatures. Although synthetic oils are generally more expensive than petroleum-based lubricants, they are worth your consideration if you are running a maximum-effort competition engine.

Ignition System



HEI Ignition

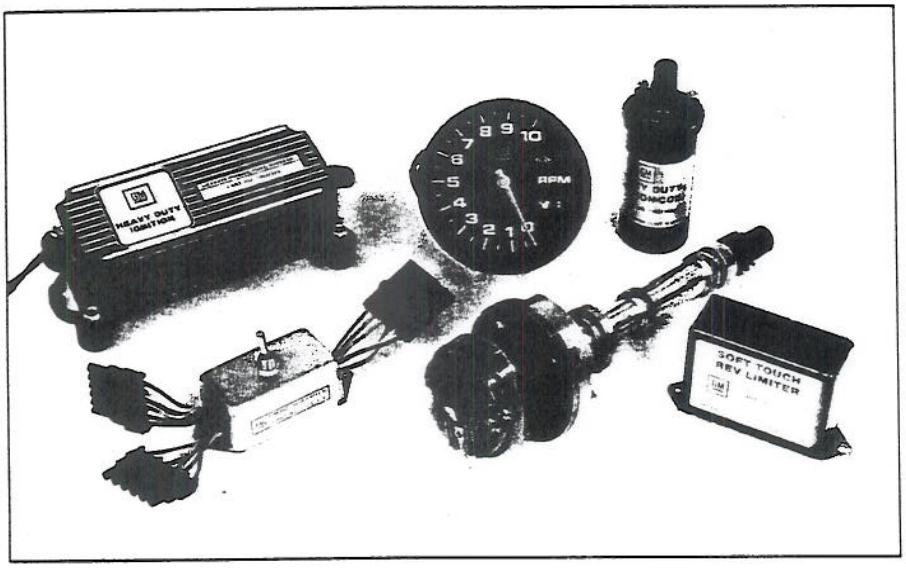
High-performance and competition engines typically operate at higher speeds and with greater cylinder pressures than production engines. These severe operating conditions place heavy demands on the ignition system.

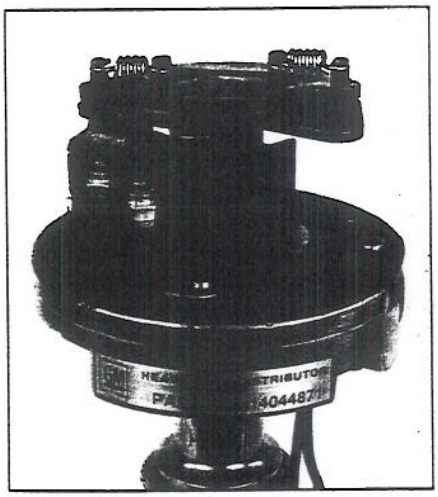
The ignition system must be capable of producing hundreds of accurately timed sparks every second: an eight-cylinder engine running at 8000 rpm requires 32,000 ignition discharges per minute! Moreover, these sparks must have sufficient energy to ignite the fuel/air mixture in the combustion chambers. Misfires, erratic spark timing, and incomplete combustion caused by an inadequate or poorly maintained ignition system can impair engine performance.

Many factors affect the efficiency of an engine's ignition system. The battery and charging system must have adequate capacity to satisfy the ignition's voltage and amperage requirements. The switches, fuses, and wires in the primary ignition system must be installed correctly and serviced periodically. The secondary spark plug wires, terminals, and boots must have adequate insulation to prevent voltage leaks and cross-firing.

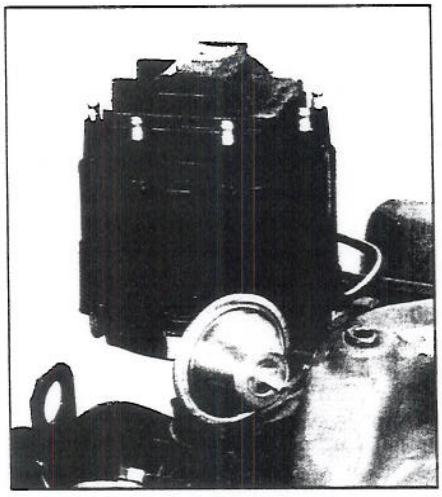
The engine's mechanical characteristics also play a role in the combustion process. The location of the spark plugs in the cylinders, the width of the plug gaps, the design of the electrodes, the height of the piston domes, and even the shape of the combustion chambers can have an impact on the ignition's ability to establish a flame front.

Advances in electronics have improved the accuracy, reliability, and performance of Chevrolet heavy-duty ignitions. Magnetically triggered ignition systems have made conventional breaker points obsolete. A mag-triggered ignition elimi-





An electronic distributor's "star wheel" reluctor induces voltage in a magnetic pickup as the distributor shaft rotates.



The self-contained HEI distributor includes a magnetic pickup, module, and coil. PN 1103436 has mechanical and vacuum advance.

nates the mechanical limitations imposed by points, springs, and distributor cams. Magnetically triggered ignitions are immune to changes in dwell and spark timing caused by worn rubbing blocks, pitted breaker points, and point bounce at high rpm. Point-type distributors are suitable only for restorations that require original equipment. The GM Motorsports Technology Group strongly recommends the use of modern magnetically triggered ignitions in all other applications.

Production and heavy-duty Chevrolet magnetically triggered ignitions are similar in their operating principles. The teeth on the distributor's timing core (often referred to as the "star wheel" or "reluctor") induce voltage in a magnetic pickup as the distributor shaft rotates. The ignition module or amplifier senses this voltage and then discharges a high-voltage secondary spark from the coil. This design has proven trouble-free in millions of production engines, and it is capable of producing sparks with excellent timing accuracy at high engine speeds.

High Energy Ignition

Chevrolet introduced the High Energy Ignition (HEI) in 1975 as a replacement for conventional point-type distributors. The HEI distributor assembly is a self-contained ignition system that includes a magnetic pickup, a module, a coil, a rotor, and a cap. The HEI's large diameter cap minimizes arcing and cross-firing between adjacent spark plug terminals. (Some Chevrolet production engines use HEI ignitions with small diameter distributor caps and remote-mounted coils to provide additional induction system clearance.) The cap's male wire terminals provide a reliable, positive connection for the spark plug leads.

Early-model HEI ignitions with conventional centrifugal and vacuum advance mechanisms are recommended for moderate performance applications such as street rods, pleasure boats, limited oval track classes, and bracket racing. The spark advance curve in these ignitions can be tailored to suit a particular car and engine combination by installing various centrifugal weights, springs, and vacuum canisters. The spark curve in late-model HEI ignitions without mechanical advance mechanisms is controlled by the vehicle's PCM (Powertrain Control Module).

The HEI distributor assembly (PN 1103436) included with the H.O. 350 engine assembly is a good choice for most high-performance applications. This distributor has conventional centrifugal and vacuum advance mechanisms, and its spark curve is suitable for most emissions-exempt engines.

The HEI distributor's magnetic pickup assembly includes a permanent magnet, a pole piece with internal teeth, and a pickup coil. When the teeth of the rotating timer core pass by the teeth of the pole piece, an induced voltage in the pickup coil signals the electronic module to open the ignition coil primary circuit. The primary current drops, and a high voltage is induced in the ignition coil secondary wiring. This voltage is routed through the rotor and plug wires to fire the spark plugs. A capacitor in the distributor suppresses radio interference.

The magnetic pickup assembly is mounted over the upper distributor housing bearing. The pickup on early-style HEI distributors with mechanical advance mechanisms is connected to the diaphragm in the vacuum canister to provide vacuum advance. The timer core is also rotated by conventional advance weights to provide centrifugal advance.

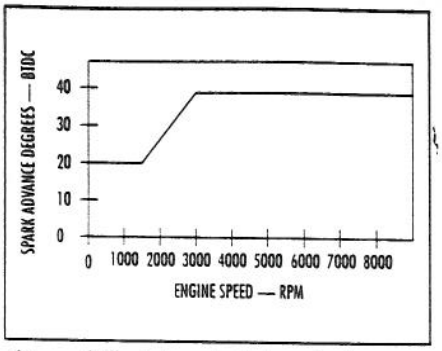
A 10 or 12 gauge ignition lead wire should be used with HEI ignitions in high-performance applications. No other electrical devices should be connected to the ignition switch. Use a separate switch and circuit for electric fuel pumps, blower motors, and other equipment. Although the HEI does not have a high average current draw, it does have a high *instantaneous* amperage draw which requires a large ignition wire lead.

If you are replacing a point-type distributor with an HEI ignition, the ballast resistor or resistance wire from the old system should be eliminated. Unlike point-type ignitions that operate at lower voltage levels, the HEI requires full battery voltage for proper operation.

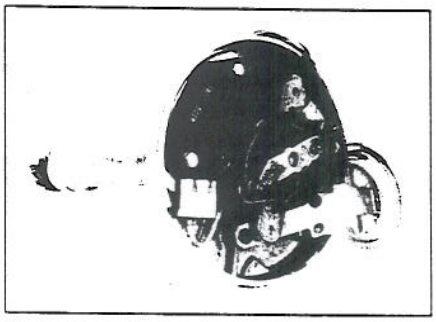
Misfiring at high engine speeds can often be cured by replacing the production carbon core resistance wires with solid core spark plug wires. High-performance spark plug wires with spiral-wound monel cores are also available; this design minimizes electrical interference with radios, rev limiters, data recorders, and other electronic components.

HEI Service Procedures

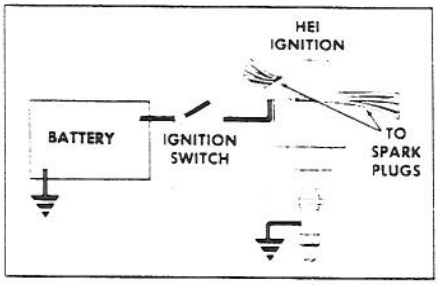
The HEI magnetic pickup and module do not require maintenance in normal service. The cap, rotor, advance weights, and weight pins should be inspected periodically for signs of wear to keep the ignition in peak operating condition.



This graph illustrates a typical spark advance curve for a competition engine. Engines with efficient combustion require less total advance.



The ignition advance curve in conventional Chevrolet distributors is controlled by centrifugal weights and springs.

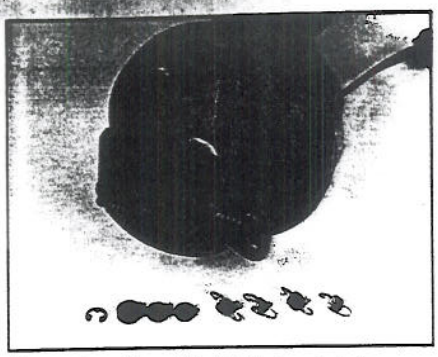


Wire an HEI ignition for racing as shown in this diagram. Use 10 or 12 gauge wire, and do not connect other devices to the circuit.

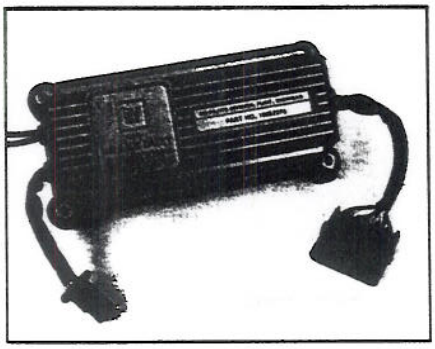
Observe the following precautions when servicing an HEI ignition system:

1. Disconnect the ignition switch feed wire at the distributor before engaging the starter when testing compression on an engine equipped with HEI ignition. When disconnecting this connector, *do not* use a screwdriver or tool to release the locking tab, as it may break.

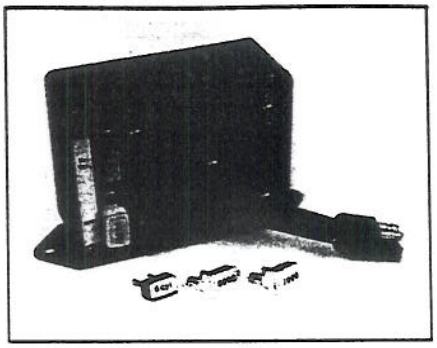
2. An HEI distributor does not require periodic lubrication. Engine oil lubricates the lower bushing, and an oil-filled reservoir provides lubrication for the upper shaft bushing.



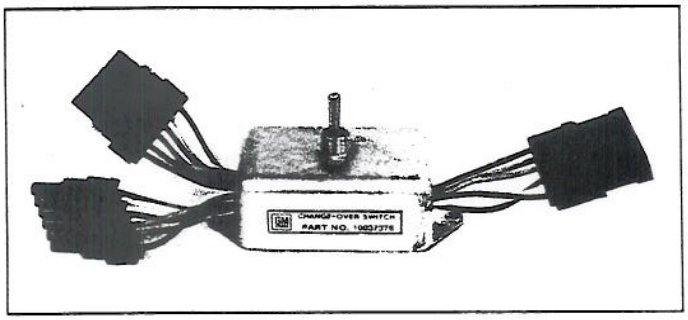
Heavy-duty Chevrolet distributors include an assortment of advance springs and limiting bushings to adjust the spark curve.



A heavy-duty GM capacitive-discharge ignition amplifier will provide reliable ignition at 10,000 rpm.



An electronic rev limiter is calibrated to the number of cylinders with a chip. Plug-in rpm modules determine the maximum engine speed.



A changeover switch allows the driver to select a back-up amplifier and rev limiter during a race in the event of an ignition malfunction.

3. The tachometer (TACH) terminal is next to the ignition switch (BAT) connector on the distributor cap or on the remote coil. The tachometer terminal must *never* be connected to ground, as damage to the module and/or ignition coil can result.

Some aftermarket tachometers may not be compatible with the High Energy Ignition system. Consult the tachometer manufacturer if questions arise.

4. Dwell is controlled by the module, and cannot be adjusted.

Electronic Ignition

Chevrolet markets a complete heavy-duty ignition system that is suitable for many high-performance and racing engines. This system includes an ignition amplifier, a heavy-duty coil, an electronic rev limiter, an electronic tachometer, wiring harnesses, and related components. Heavy-duty distributors for Chevrolet V8 and 90-degree V6 engines are also available. This coordinated heavy-duty ignition system is designed to provide dependable off-highway performance under severe operating conditions.

The heart of the Chevrolet heavy-duty ignition is a capacitive-discharge ignition amplifier (PN 10037378). This control box is suitable for all high-compression racing engines with a maximum engine speed of 10,000 rpm. It has multi-spark capabilities, producing a series of sparks for 20 degrees of crankshaft rotation. The control box has special internal bracing and rubber shock mounts to dampen vibrations. The heavy-duty ignition amplifier has a maximum current draw of 10 amperes. It plugs directly into Chevrolet heavy-duty distributors.

The ignition control has a connector for an electronic rev limiter (PN 10037379). This rev limiter will prevent an engine from overspeeding in the event of a missed shift, a driveline failure, or a loss of traction. It does not shut down the engine, but instead cuts the current to individual cylinders until the engine speed falls below the chosen rpm limit. This "soft touch" rev limiter includes a set of chips, or modules, which adapt the unit to four-, six-, and eight-cylinder engines.

The engine's maximum rpm point is determined by plugging a second chip into the rev control. Three chips are supplied with the rev control to limit engine speed to 6000, 7000, or 8000 rpm. Additional chips are available to set the maximum engine speed in 200 rpm increments. Each kit includes five chips.

Two wiring harnesses are available for the heavy-duty ignition control. PN 10039932 should be used when the control box is mounted in the engine compartment. PN 10037377 has longer wires to allow the box to be mounted in the passenger compartment, where it is protected from high temperatures.

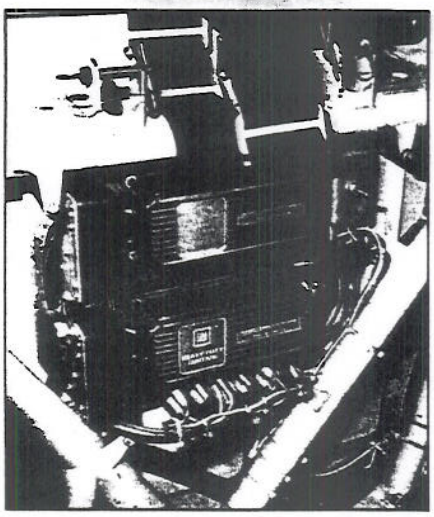
A changeover switch is available as PN 10037376. This switch enables the driver to select a back-up control box in the event of an ignition malfunction during a race. A second ignition box and rev limiter are required when a changeover switch is installed.

The recommended ignition coil for the heavy-duty Chevrolet ignition is PN 10037380. This coil has an alkyd top that prevents arcing to the terminals. It is oil-filled to dissipate heat under severe operating conditions.

Chevrolet heavy-duty distributors do not have provisions for a mechanical tachometer drive. A five-inch diameter electronic tachometer (PN 10038474) is recommended for use with these distributors. This tachometer reads to 10,000 rpm, and has an electronic memory feature that recalls the highest engine speed by flipping a switch on the tachometer face. A pushbutton on the tach resets the memory. Two 8000 rpm electronic tachometers are also available: PN 10185001 has a 3¾-inch diameter dial, and PN 10185002 has a 5-inch dial.

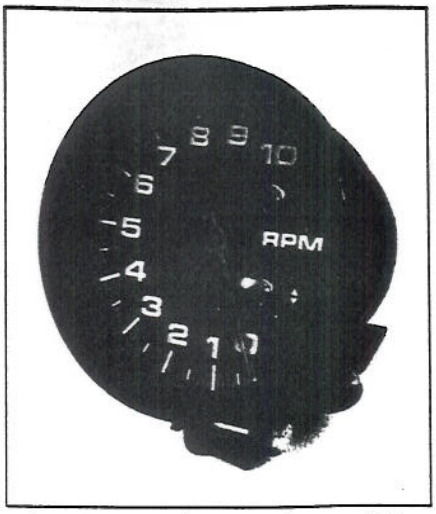
Heavy-duty ignition systems should be wired directly to the battery using a high-quality toggle switch, a fuse or circuit breaker, and heavy-gauge wire. Do not connect the ignition control to the vehicle's common fuse panel or terminal strip, and do not share the wiring for the ignition box with other components.

Do not use solid core spark plug wires with a heavy-duty electronic ignition if your car is equipped with rev limiters, pit radios, data recorders, or other devices that are susceptible to electrical "noise." High-performance radio suppression wires with spiral-wound cores are recommended to eliminate electrical interference caused by high-output ignitions.



This well-prepared race car has a complete spare ignition system. Flipping the changeover switch activates the second ignition control box.

An oil-filled coil (PN 10037380) is recommended for heavy-duty ignitions. This coil has an alkyd top to prevent arcing.



A GM 10,000 rpm electronic tachometer (PN 10038474) has a memory feature that recalls the highest engine speed.

Ignition System Troubleshooting

Distributors and ignition systems are frequently neglected until some engine problem appears. New components may have hidden defects, and used parts can deteriorate with use. The following troubleshooting tips and installation recommendations apply to most Chevrolet point-type, HEI, and heavy-duty electronic ignitions.

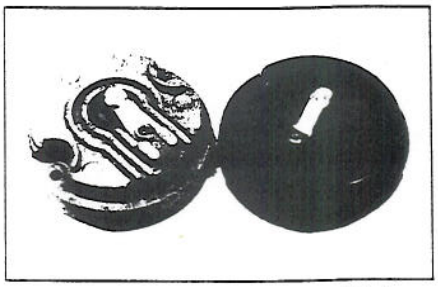
If the ignition system is malfunctioning, first make sure that the battery is properly charged and that all connections are tight and free of corrosion. Check the voltage at various points to verify that fuses, switches, and wires are in good condition. If the problem persists, check for the following defects:

1. Examine the distributor for loose or worn centrifugal advance weights, pins, and broken welds in the centrifugal advance mechanism and distributor driveshaft. Inspect the rotor blade tip.

2. Check for a worn, damaged, or missing centrifugal advance limiting bushing (not used in HEI distributors). Loss of this bushing on the advance stop pin during a race advances ignition timing several degrees. This can in turn cause detonation and serious engine damage. Production plastic advance limiting bushings can be replaced with a metal bushing which can be brazed or soldered to the pin.

3. Damage to the pickup coil or breaker point lead wires. A clean, positive connection should be maintained between the distributor and the wiring harness. An intermittent connection can produce random misfiring and spark scatter. Pickup coil lead wires are occasionally pinched inside the distributor; a grounded wire can cause distributor failure.

All ignition wiring should be examined for brittle or cracked insulation, broken strands, and loose or corroded connections. The secondary leads in the coil and distributor cap should be checked to make sure they are pressed all the way down in their inserts. Rubber boots should be tight in place over the connections. Inspect the distributor cap and coil for cracks which would allow high voltage to jump to ground. The rotor and the inside of the cap should be checked for cracks and carbon paths.



An "E" gap rotor (right) has a shorter blade than a high-performance rotor. The "E" gap can cause misfire by increasing resistance.